U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB-252 700

GUIDELINES FOR IDENTIFICATION AND EVALUATION OF LOCALIZED VIOLATIONS OF CARBON MONOXIDE STANDARDS

GCA CORPORATION

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

JANUARY 1976

EPA-901/9-76-001

140254

GCA-TR-75-35-G(1)

PB 252 700

GUIDELINES FOR IDENTIFICATION AND EVALUATION OF LOCALIZED VIOLATIONS OF CARBON MONOXIDE STANDARDS

FINAL GUIDELINE REPORT

Contract No. 68-02-1337
Task Order No. 6

Prepared For
U.S. ENVIRONMENTAL PROTECTION AGENCY
Region I Office
Boston, Massachusetts

January 1976

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

GCA/TECHNOLOGY DIVISION
BEDFORD, MASSACHUSETTS 01730

117

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-901/9-76-001	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Guidelines for Identification and Evaluation of Localized Violations of Carbon Monoxide Standards		5. REPORT DATE January 1976
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Theodore P. Midurski, Alan H. Castaline		8. PERFORMING ORGANIZATION REPORT NO. GCA-TR-75-35-G(1)
9. PERFORMING ORGANIZATION NAME AND ADDRESS GCA CORPORATION GCA/TECHNOLOGY DIVISION Bedford, Massachusetts 01730		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO. 68-02-1337 TO No. 6
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Region I Office Boston, Massachusetts 02203		13. TYPE OF REPORT AND PERIOD COVERED Final Report
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

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17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Atmosphere Contamination Control Atmospheric Models Carbon Monoxide Exhaust Gases Traffic Engineering Transportation/Urban Planning	Air Pollution Model Automobile Exhaust Highway Corridor Air Quality Analyses Relationships Between Traffic and Nearby Air Quality	13/13B

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 117
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE $5.50-2.25

EPA Form 2220-1 (9-73)

EPA-901/9-76-001 GCA-TR-75-35-G(1)

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Final Guideline Report

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January 1976

Contract No. 68-02-1337
Task Order No. 6

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This report was furnished to the U.S. Environmental Protection Agency by the GCA Corporation, GCA/Technology Division, Bedford, Massachusetts 01730, in fulfillment of Contract No. 68-02-1337, Task Order No. 6. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the U.S. Environmental Protection Agency or of the cooperating agencies. Mention of company or product names is not to be considered as an endorsement by the U.S. Environmental Protection Agency.

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This report presents guidelines for the identification and evaluation of localized violations of carbon monoxide air quality standards in the vicinity of streets and highways. The guidelines are provided to facilitate the rapid and efficient review of CO conditions along existing roadway networks, without the need for extensive air quality monitoring, and are based upon the use of limited traffic data. Two stages of review are provided for. Preliminary screening, performed with simple nomographs included herein, simply identifies those locations with the potential to violate CO standards; no quantitative estimate of CO concentrations results from preliminary screening. Verification screening, using procedures and forms provided herein, allows for consideration of additional site-specific conditions and provides quantitative estimates of maximum CO concentrations. Both screening procedures are performed manually and are based upon the EPA Indirect Source Review Guidelines. Data collection procedures, computation techniques, and forms are recommended, and examples are provided.

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ACKNOWLEDGMENTS

Numerous individuals and several organizations have been helpful in carrying out the work presented in this report. For these contributions GCA/Technology Division extends its sincere gratitude.

Project direction and technical guidance were given by the Project Officer, Mr. John Calcagni of Region I, and by Mr. Gary Hawthorne and Mr. Jerry Kurtzweg of the Office of Transportation and Land Use Policy, U.S. Environmental Protection Agency.

Several state and local agencies supplied information and other assistance for this work. Particular thanks go to the Bureau of Transportation Planning and Development of the Massachusetts Department of Public Works, the City of Waltham, Massachusetts, and the Office of Air Quality Planning and Standards of the U.S. Environmental Protection Agency.

SECTION I

INTRODUCTION

A. PURPOSE

This volume presents a set of guidelines for the identification and analysis of locations with the potential for experiencing violations of the National Ambient Air Quality Standard for carbon monoxide. These guidelines are intended for engineers, planners, and other officials who must consider the effects on air quality of certain traffic management decisions and whose responsibility includes traffic planning to control CO "hot spots." These guidelines are designed to identify potential carbon monoxide hot spots, using only data on automobile traffic and thus avoiding the need for time-consuming and costly monitoring of air quality at every potential hot spot.

B. OVERVIEW OF THE PROCESS FOR CONTROL OF HOT SPOTS

1. General

Controlling CO hot spots requires several steps: identification of the potential hot spots, detailed analysis of each hot spot, and selection of control measures. Although this document is primarily concerned with identification and analysis of carbon monoxide problem areas, it is well to bear in mind that the ultimate purpose of these procedures is to allow the selection of suitable control measures to insure that public health will be protected, by complying with the National Ambient Air Quality Standards. To that end, the following text presents a brief overview of the entire process of controlling hot spots, from identification to implementation of control measures.

Choosing among alternative traffic measures for control of CO hot spots will be much like many other public investment decisions. One must balance the benefits and costs and choose accordingly. When meeting air quality standards is one of the goals, the nature of the choice is somewhat altered, however, because attainment of the specified standard is necessary to protect public health. Consequently, meeting air quality standards will be the first consideration when selecting among alternative actions for control of hot spots. Once that criterion has been satisfied, then the choice among alternatives can be made on the basis of costs and other issues, as with other public investments.

2. Recommended Process

Figure 1 is a flow diagram for the overall process for selection of CO control measures. Each of the numbered steps will be briefly described.

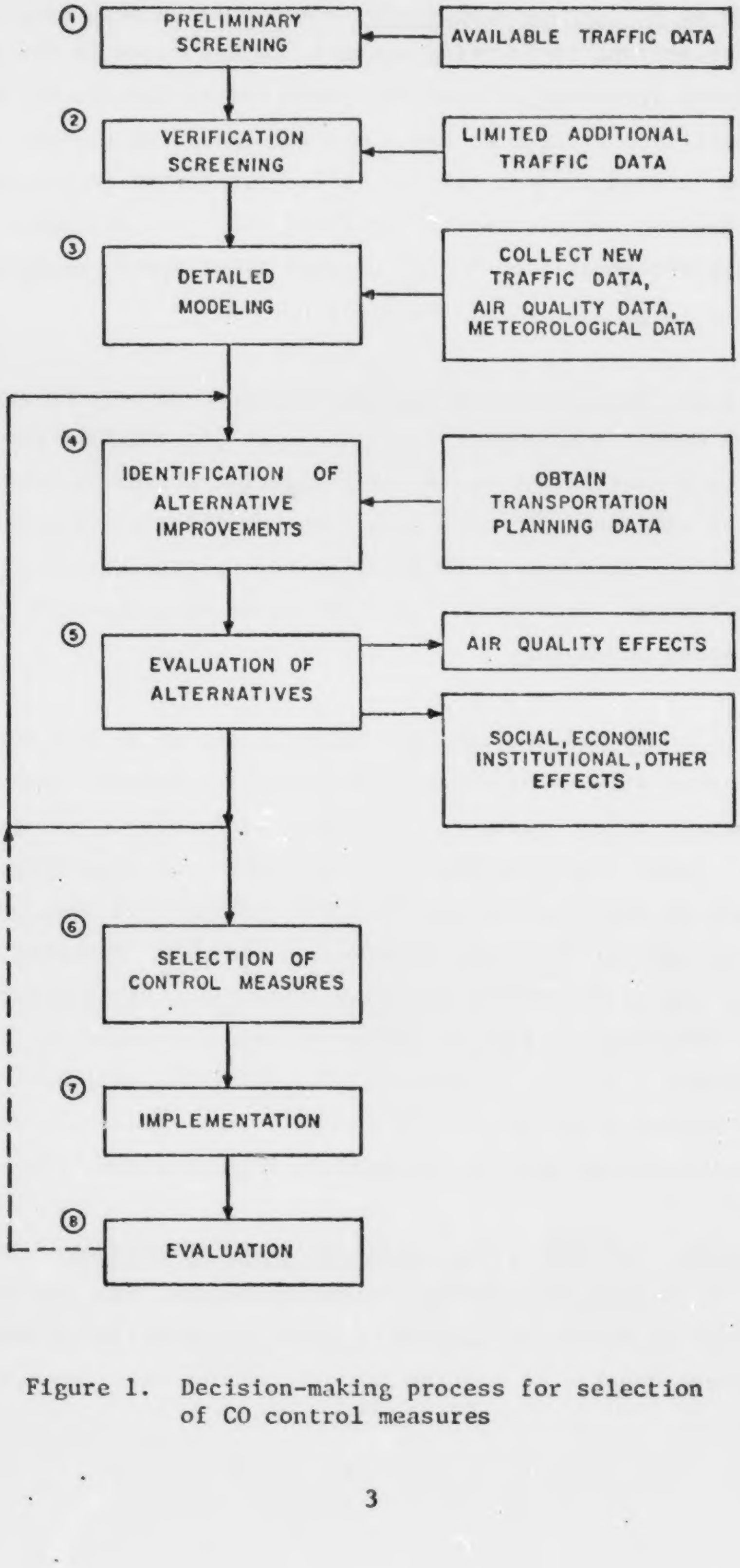
①
PRELIMINARY SCREENING
AVAILABLE TRAFFIC DATA
②
VERIFICATION SCREENING
LIMITED ADDITIONAL TRAFFIC DATA
③
DETAILED MODELING
COLLECT NEW TRAFFIC DATA, AIR QUALITY DATA, METEOROLOGICAL DATA
④
IDENTIFICATION OF ALTERNATIVE IMPROVEMENTS
OBTAIN TRANSPORTATION PLANNING DATA
⑤
EVALUATION OF ALTERNATIVES
AIR QUALITY EFFECTS
SOCIAL, ECONOMIC INSTITUTIONAL, OTHER EFFECTS
⑥
SELECTION OF CONTROL MEASURES
⑦
IMPLEMENTATION
⑧
EVALUATION

Figure 1. Decision-making process for selection of CO control measures

a. Step 1: Preliminary Screening - Preliminary screening of roadways and intersections to identify possible CO hot spots is the first task. Preliminary screening procedures, presented in Section II of this volume, use generalized procedures and a minimum amount of traffic data; available data can be used in most cases. To facilitate the rapid screening of many locations, simple charts and nomographs are provided. The output is simply the identification of potential hot spots; no quantitative estimates of CO concentrations are produced.

b. Step 2: Verification Screening - Verification screening is a more detailed manual analysis of locations that are shown by preliminary screening to be potential hot spots. Verification screening uses a larger amount of site-specific data than does preliminary screening, and produces quantitative estimates of CO levels. New traffic data will be needed in many instances. Section III of this volume describes the procedures for verification screening.

c. Step 3: Detailed Modeling - Once the hot spots are identified, they are analyzed with detailed analytical models (usually some form of computer model) using procedures described elsewhere in the literature or, in some cases, using the detailed procedures for verifying hot spot potential as described in Sections III and IV. Modeling provides the base case against which alternatives are judged. Modeling generally requires the collection of new data on traffic, air quality, and meteorology. Modeling reveals the degree of emission reduction that is needed from traffic controls. A variety of models are available, some from EPA and DOT and others from the private sector. Model selection will not be described here but must be tailored to the individual site in question.

d. Step 4: Identification of Alternative Improvements - Knowing the amount of CO emissions reduction that is needed, the planner can begin to narrow the choice of control measures by identifying those alternatives that appear capable of meeting the air quality requirements. New (or existing) transportation planning data are obtained at this point, to allow forecasting emissions in future years and to allow consideration of macroscale traffic changes when necessary. The alternatives to be evaluated should be capable of achieving the NAAQS at each hot spot, after accounting for "tail pipe" controls such as new vehicle pollution control devices.

e. Step 5: Evaluation of Alternatives - Evaluation of air quality effects uses the models from Step 3 and determines if the NAAQS would be met. For those alternative measures that would satisfy the air quality criteria (only), the other effects are then identified and quantified. If the alternative control measures are inadequate, or if it is prudent to examine additional alternatives because of implementation obstacles that may arise, the process would revert to Step 4 at this point.

f. Step 6: Selection of Control Measures - Selecting among the alternative measures requires balancing the non-air quality effects (assuming that only those measures that will achieve NAAQS are being considered at this point). The thrust of the choice is to minimize the adverse impacts. Often, however, the choice will require weighing effects of various types. For example, the decision might be between two control measures that are similar except that one requires more capital outlay but is more beneficial to fuel consumption. Such choices are commonly made in transportation facility planning. This Guideline cannot detail how to make such choices; an excellent summary of the process has recently been published[1] and includes a recommended procedure for considering nonmonetary costs and benefits.

g. Step 7: Implementation - Having selected a measure, it must be implemented. When planning measures, the time to accomplish this step should be considered in all analyses of effectiveness.

h. Step 8: Evaluation - After implementation, the traffic and air quality should be monitored and calculations made to determine if NAAQS will be met. Rarely are planning predictions exact; in some cases it will be necessary to adjust the control measures, or supplement them, in order to (1) meet air quality goals or (2) ameliorate unexpected impacts.

C. HOW TO USE THESE GUIDELINES

As described above, there are two screening tasks for which procedures are provided in this volume. The sequence of using this volume for screening is to first become familiar with this guideline, then to use the procedures in Section II for a preliminary screening of all important intersections and midblock locations. The preliminary screening provides a yes/no determination; those locations identified as possible hot spots are then analyzed in more detail, using the verification procedures in Section III. Sections II and III provide step-by-step instructions and supply all necessary charts and computation forms. Section IV provides more detailed information that is necessary for both screening tasks.

Appendix A provides maps of Waltham, Massachusetts, to illustrate the type of traffic flow maps that will be needed for screening. Appendixes B and C provide examples of the preliminary screening and verification procedures, respectively, using locations in Waltham and include location sketches that show that type of physical detail needed for using these procedures. The three appendixes should be helpful when first using these guidelines, as illustrations of the procedures.

D. BASIS FOR THE PROCEDURES

1. Previous Method as the Basis

Both the preliminary screening procedures and the verification screening procedures presented in this report are based upon a technique previously developed for determination of carbon monoxide concentrations near facilities such as major shopping centers. The technique is referred to as the Indirect Source Review Guideline and is described in an earlier EPA report.[2]

Before using these procedures, it is well to understand their technical basis in order to recognize their assumptions and limitations. The following is a discussion of the technical basis for the procedures, beginning with a brief explanation of the key factors influencing CO concentrations.

2. Nature of Carbon Monoxide

On or adjacent to streets or highways, the primary contributor to carbon monoxide (CO) concentrations is automotive traffic on the nearby roadways. The highest concentrations of CO have been found to occur near intersections, where vehicle speeds are generally quite low and where acceleration, deceleration, and idling occur; these types of vehicle operating modes tend to produce high rates of carbon monoxide emissions. The actual concentration of CO at a particular location is the sum of (1) concentrations attributable to traffic in the immediate vicinity and (2) background concentrations attributable to more remote sources of CO. In most instances where CO levels are higher than allowed by the National Ambient Air Quality Standard (NAAQS), it has been found that the contribution from nearby sources is substantially more important than the background. Consequently the procedures used in this document focus on calculation of the concentrations from nearby sources, and simply add a measured or assumed background concentration.

The concentration of carbon monoxide attributable to nearby sources can be expressed as follows:

$$C = V \cdot E \cdot K \cdot \frac{1}{s} \qquad (1)$$

where C = concentration of CO at a particular location

V = traffic volume (in vehicles/hour, say)

E = average emissions rate (in grams/hour, say), which is a function of vehicle types, speeds, and age.

K = proportionality factor that accounts for the geometry of the situation, including wind direction and distance from roadway to receptor location.

S = wind speed

It can be seen from equation (1) that, at a given location, carbon monoxide concentrations are directly proportional to traffic volume and inversely proportional to wind speed. The emissions rate, E, is highest when vehicle speeds are low, such as when volumes are highest. Thus, the highest CO concentrations will tend to occur when traffic volumes are the highest and when wind speeds are low.

The NAAQS for carbon monoxide specifies two limits. First, there is a limit of 35 parts per million (ppm) for a 1-hour average concentration. Second, there is a limit of 9 ppm for an 8-hour average concentration. The NAAQS specifies that each of these limits may be exceeded only once per year. Thus, the process of screening for hot spots must be designed to examine the highest concentrations likely to occur in a year.

3. Basis for the Screening Procedures

In developing the screening procedures, a distinction was made between (1) the factors that influence CO levels and are site-specific and (2) the factors that do not vary significantly from one site to another. Of the factors mentioned above, the highly site-specific elements are traffic volume (V), vehicle speeds (included in E), and the distance from the roadway to the site being evaluated (part of K). Each of these is thus determined separately for each location to be screened. Several other factors are common to a given state or metropolitan area, and are determined just once for each screening program, namely the emission factors (determined by the local vehicle mix and included in E). The remaining factors relate to meteorology, namely wind speed (S) and direction (which is included in K).

In a given metropolitan area, conditions of low wind speed occur with a predictable frequency; the frequency of such occurrences does not vary substantially among the various geographic locations in an area. Consequently, the procedure presented in the Indirect Source Guideline and used here has a standard low wind speed (1 meter/sec or 2 mph) that is used for all locations. As for wind direction, the procedure assumes that the wind is at an angle to the roadway that tends to produce the highest concentrations of CO. This assumption eliminates the need to analyze seasonal wind direction frequencies separately for each intersection or midblock location to be analyzed. This assumption is reasonable, because any given location will tend to experience every wind angle during a year.

In summary, the screening procedure uses (1) a standardized set of meteorological conditions, (2) a regional set of emission factors, and (3) data on traffic volumes, traffic speeds, and distance from roadway to receptor specific for each site to be analyzed.

4. Limitations of the Procedure

The purpose of the screening procedure is to efficiently identify locations with the potential for violation of the NAAQS for carbon monoxide. In order to achieve an efficient process, it was necessary to make a number of simplifying assumptions, several of which have already been mentioned. Where such assumptions were made and where generalized conditions or relationships were included, it was necessary to be conservative;

that is, it was desirable to overpredict CO levels rather than underpredict them, in order to insure that potential hot spots would not be missed. Each succeeding stage of analysis has fewer assumptions, however. Preliminary screening requires the least effort per site and thus has the greatest number of simplifying assumptions. Verification screening allows a greater number of localized adjustments and thus can be more accurate, requires greater effort per site, but need only be performed for sites shown by preliminary screening to be potential hot spots. Modeling, not presented in this volume, requires the greatest effort for each site but potentially is most flexible and accurate.

a. Meteorological Assumptions - The wind conditions used in this volume are identical with those in the EPA Indirect Source Review Guideline.[2] There are no provisions for adjustments here, although there are techniques described in Reference 2 for compensating for different wind speeds. To illustrate the reasonableness of the assumed conditions, data for Boston were examined. In the winters of 1967 to 1972, wind speeds were between 0 and 3 mph (i.e., in the range assumed here) during more than 2 percent of the time.[*] (Recall that the hot spot guideline is intended to find the peak likely CO level, which would be representative of the second-worst hour and thus would be exceeded less than 0.1 percent of the time.)

Another meteorological factor is ambient temperature. Inasmuch as the peak CO concentrations usually occur in the winter, at least in the Northeastern U.S. where these screening procedures will first be applied, an ambient temperature of $0^{o}C$ ($32^{o}F$), is assumed. This differs from the Indirect Source Review Guidelines which uses $68^{o}F$-$86^{o}F$, judged to be reasonable for that application. Colder temperatures produce higher emission rates, and temperatures lower than $0^{o}C$ are certainly not uncommon. As an example, the mean daily average temperature in Boston is $30^{o}F$ in

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[*] Atmospheric stability consistent with the assumptions herein, also.

January and February, which indicates there are many hours with temperatures below the assumed 32°F; also there are 94 days per year in Boston during which the minimum temperature is 32°F or below.[3] Thus, the assumed condition of 0°C is reasonable but not particularly conservative.*

b. Traffic Assumptions - The screening technique herein is designed for a minimum of effort. To minimize the need for collection of special traffic data, the preliminary screening is based upon using average daily traffic (ADT), a statistic that is normally available for all major roads, rather than using hourly data. Hourly traffic must be used for calculating CO concentrations, however, so the preliminary screening procedure incorporates the following assumptions that relate ADT to hourly travel volumes:

- Peak hour traffic represents 8.5 percent of the ADT.
- The directional split on two-way facilities during the peak hour is about 40 percent to 60 percent at mid-block locations and 50 percent to 50 percent at intersections.
- For multi-lane facilities, the volume on the outside lanes (towards the shoulder) is generally lower than the inner lane volumes.

Again, each of these assumptions is judged to be reasonable for the purpose of preliminary screening. As for verification screening, there is a provision for determining actual hourly volumes. In both cases, there are additional assumptions regarding signal operations and speed-volume-capacity relationships, which are discussed further in Sections II, III, and IV and in Reference 2.

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*Also, at present there are no correction factors available for ambient tempreatures below 0°C.

c. Assumed Conditions - The data provided here for screening is based upon the 1977-1978 winter period; that is, the assumed vehicle population has the emission characteristics of that time. This date was chosen because it will be the first winter after the present statutory deadline of June, 1977, for meeting CO standards everywhere in the U.S. Note, however, that the curves provided here for preliminary screening to not include inspection/maintenance programs or other "tail pipe" controls, because not all areas will have them in effect. The verification screening procedures do allow for such tail pipe control measures to be accounted for.

d. General Comments - The procedures described herein embody a number of simplifying assumptions, the most important of which have been described. Such simplifications are necessary for the screening process, for otherwise the screening effort would be considerably greater. These assumptions will apply more accurately to some locations than to others. That is, the user should recognize that the assumed conditions will not be representative of conditions at all locations. In general, the procedures are intended to produce a reasonable estimate of peak CO concentrations. When site-specific data could not be used, the assumed general conditions were chosen to be conservative. This prevents overlooking hot spots. Later stages of analysis can be more site-specific, less conservative, and thus more precise. In particular, the first-stage (preliminary) screening is qualitative, and will only identify those sites with the potential for violations of the NAAQS. The second-stage (verification) screening allows some additional site-specific conditions to be considered, and will be less conservative than preliminary screening, but still produces approximations of peak CO levels. The procedures are not intended to replace more detailed modeling, especially for circumstances not consistent with the assumptions.

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SECTION II

TASK I - PRELIMINARY SCREENING

A. INTRODUCTION

Hot spot screening can be defined as the analysis of a highway network in order to identify specific locations where carbon monoxide concentration may exceed National Ambient Air Quality Standards which specify maximum ambient concentrations allowable under provisions of the Clean Air Act. The purpose of the screening procedures developed herein is to provide a practical, economical method of identifying locations where appropriate action may be required to reduce ambient carbon monoxide concentrations. In this regard, appropriate action implies implementing any of a number of plans or measures available for reducing carbon monoxide emission levels.

On or adjacent to roadway networks, the primary source of carbon monoxide is vehicular traffic using that network. The highest concentrations typically occur in the vicinity of intersections where vehicle speeds are generally quite low and acceleration, deceleration, and idling, occur. This is not to say, however, that concentrations in the vicinity of freely flowing traffic do not ever exceed air quality standards. The implication intended is that any technique that is developed to identify possible carbon monoxide hot spots, must focus on the entire street network including intersections and midblock locations as well as expressways.

A technique has been developed that does permit analysis of intersections, midblock locations, and expressways based on data developed by the U.S.

Environmental Protection Agency and presented in a document entitled Guidelines for Air Quality Maintenance Planning and Analysis, Volume 9: Evaluating Indirect Sources.[1] This technique provides for separate analyses of signalized intersections, nonsignalized intersections, midblock sections of arterial streets, and expressways. The technique is presented as two separate tasks - the first being the preliminary screening procedure which facilitates identifying potential locations where hot spots may exist. This is accomplished using only the most basic traffic data inputs and is intended to provide only a "go- no go" type of analysis; in other words, it indicates only whether there is potential for a hot spot to exist but does not attempt to quantify the potential. The analysis is conducted utilizing a series of nomographs that express a relationship between certain roadway characteristics (physical and operational) and expected "worst case" air quality. The second task involves verifying the hot spot potential of a location by using more specific data regarding that location, and established relationships (again, depicted by a series of nomographs) between air quality and nearby traffic characteristics. Instructions for performing both screening tasks are provided in this document; initial screening* is discussed in the remainder of this Section while Section III discusses the second-stage analysis procedure.

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*The terms Preliminary Screening and Initial Screening are used interchangeably throughout this document.

B. OVERVIEW OF THE PRELIMINARY SCREENING PROCESS

A description of the preliminary screening process must include discussions of three elements critical to the process; these include (1) the data required, (2) the nomographs that relate the roadway characteristics to air quality, and (3) a set of standard forms on which the analysis is performed and the results reported. Each of these elements will be described below.

1. Data Requirements

The entire preliminary screening task may be possible to complete for many communities with only a minimal field data collection effort. Data required includes areawide traffic volume data and a street inventory of sufficient detail to indicate the lane composition (use and number of lanes), traffic control utilized (mainly, the locations of signalized intersections are of primary importance), and whether various streets operate one-way or two-way. Also, additional backup data are required in order to estimate the lane capacity of arterial streets and expressways, as will be mentioned later.

a. Traffic Volume Data - Traffic volume data should be summarized in the form of a traffic flow map indicating the highest monthly average daily traffic (ADT) volumes for the winter season, projected to the year 1977. Volume data need not be developed for every street on the network; of primary interest should be: (1) those streets and highways on the Federal Aid System, (2) those not on the Federal Aid System but which are controlled by traffic signals; and (3) those not on the Federal Aid System but which are considered by local officials to be "important" or high volume facilities.

Traffic volume data is perhaps the most abundant data element available concerning a highway network. The intent here is that existing data be used wherever possible, implying that existing volume data should be available in most instances to develop a suitable traffic flow map. In many communities where traffic studies or transportation plans have been developed, flow maps may already be available, requiring only minimal updating. As an example, a traffic flow map for the City of Waltham, Massachusetts (see Appendix A, Figures A-3a and A-3b) was developed with only minimal effort utilizing an existing flow map extracted from an Areawide TOPICS (Traffic Operations Program to Increase Capacity and Safety) Plan. Development of flow maps, however, should be carefully guided by cognizant state highway and transportation planning officials.

b. Highway Inventory Data - Highway inventories are normally available from state transportation, planning or highway departments. These inventories should be made available for each community where hot spots are being investigated. The required data that can be obtained from these inventories include descriptions of operational characteristics of the roadways (e.g., one-way or two-way operation); information regarding the number of lanes, use of medians, functional classification, etc., and occasionally, volume data. Also, data must be obtained regarding intersectional traffic control, particularly the locations where traffic signals are utilized. It is helpful if the locations of all signalized intersections are plotted on a base map.

c. General Backup Data - Other data elements are required which may not be available from previous studies or from existing inventories. Included is information required to estimate the lane capacity of streets on the network, mainly, estimates of truck factors, knowledge of conditions such as restricted lateral clearances, severe terrain features, etc. This information can be obtained through local planning or engineering personnel and by field reconnaissance. For a comprehensive discussion of roadway lane capacity, the reader is referred to the Highway Research Board's Special Report No. 87, the 1965 Highway Capacity Manual.[2]

2. Nomographs for Preliminary Screening

The nomographs for preliminary screening provide the basic tool for relating various traffic and roadway characteristics to hot spot potential. In particular, these nomographs relate a roadway's average daily volume demand and capacity characteristics to potential for exceeding the National Ambient Air Quality Standard for 8-hour average concentrations of carbon monoxide (9.0 parts per million). Separate sets of nomographs are presented for three distinct types of analysis including signalized intersections, nonsignalized intersections, and for conditions where uninterrupted flow prevails. Each of these sets is discussed below.

a. Signalized Intersections - Eight separate nomographs are presented. Each of the nomographs was developed for screening intersection legs of a particular configuration (e.g., the nomographs presented in Figure 2 was developed to screen 2-lane, 2-way intersection legs in congested areas while Figure 5 presents a nomograph developed for screening 3-lane, 2-way legs in noncongested areas). Included are nomographs developed for screening the following leg configurations:

- 2-lane, 2-way (congested area)
- 2-lane, 2-way (noncongested area)
- 3-lane, 2-way (congested area)
- 3-lane, 2-way (noncongested area)
- 4-lane, 2-way (congested area)
- 4-lane, 2-way (noncongested area)
- 3-lane, 1-way
- 2-lane, 1-way

A series of five curves appears on each nomograph. Each of these curves represents a particular configuration of the cross street (with respect to the leg being screened). Curves representing the following cross street configurations are plotted on each nomograph:

- 2-lane, 1-way
- 2-lane, 2-way
- 3-lane, 1-way
- 3-lane, 2-way
- 4-lane, 2-way

These are represented by curves A through E, respectively.

Each of the curves is a plot of the ADT on the intersection leg under analysis (abscissa) versus the ADT on the cross street (ordinate). Each point on any of the curves, then, represents that combination of traffic volumes (on the street under analysis and the cross street) which, under certain assumed conditions, would result in ambient carbon monoxide concentrations at or very close to the maximum level permitted by the National Ambient Air Quality Standard for 8-hour average concentrations (9.0 ppm). This is to say that for any particular configuration of street (under analysis) and cross street, if their respective ADT's are plotted on the nomograph and the point plotted falls on or above the (cross street) curve, the implication is that resulting carbon monoxide concentrations are potentially in the vicinity of 9.0 ppm or more, indicating that the leg has hot spot potential. Plotting the ADT's (for winter 1977-78) in this manner and noting where the plot lies with respect to the cross street curve, is essentially the entire procedure involved for using the nomographs. The appropriate nomograph is selected based on the configuration of the leg being analyzed while selection of the appropriate curve on the nomograph is based on the cross street configuration.

1. Nomographs for Screening Signalized Intersections - Following are the eight nomographs to be used for the preliminary screening of signalized intersections (Figures 2 through 9).

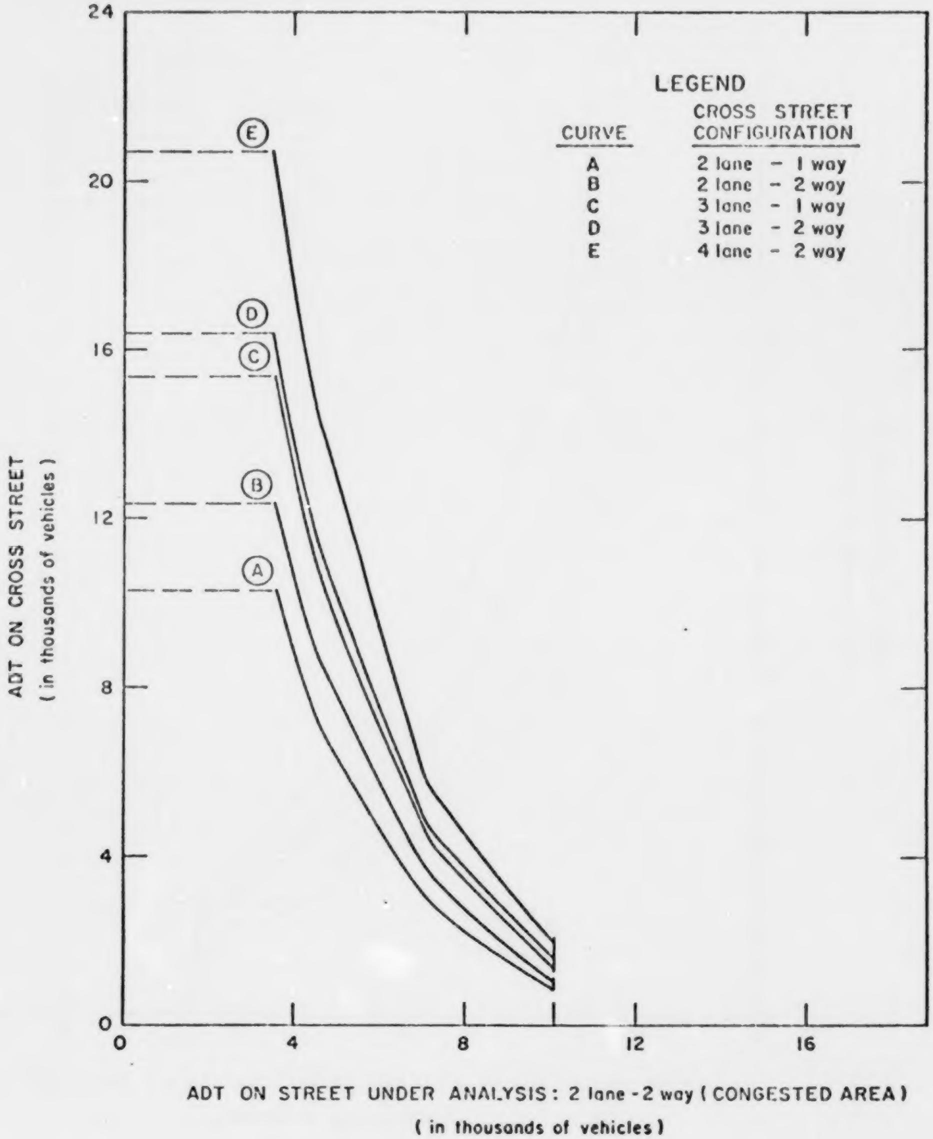


Figure 2. Critical volumes at signalized intersections. Analysis of a 2-lane 2-way street in a congested area.

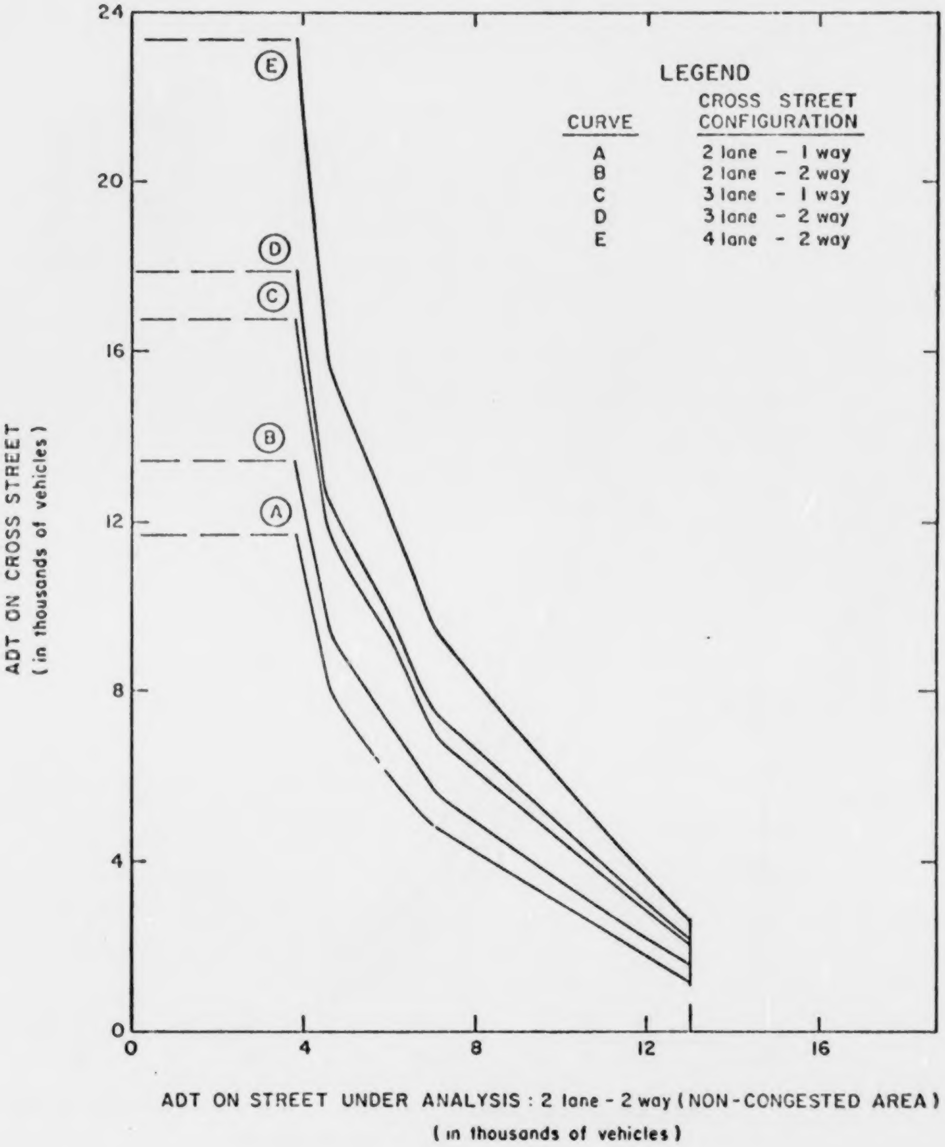


Figure 3. Critical volumes at signalized intersections. Analysis of a 2-lane 2-way street in a noncongested area.

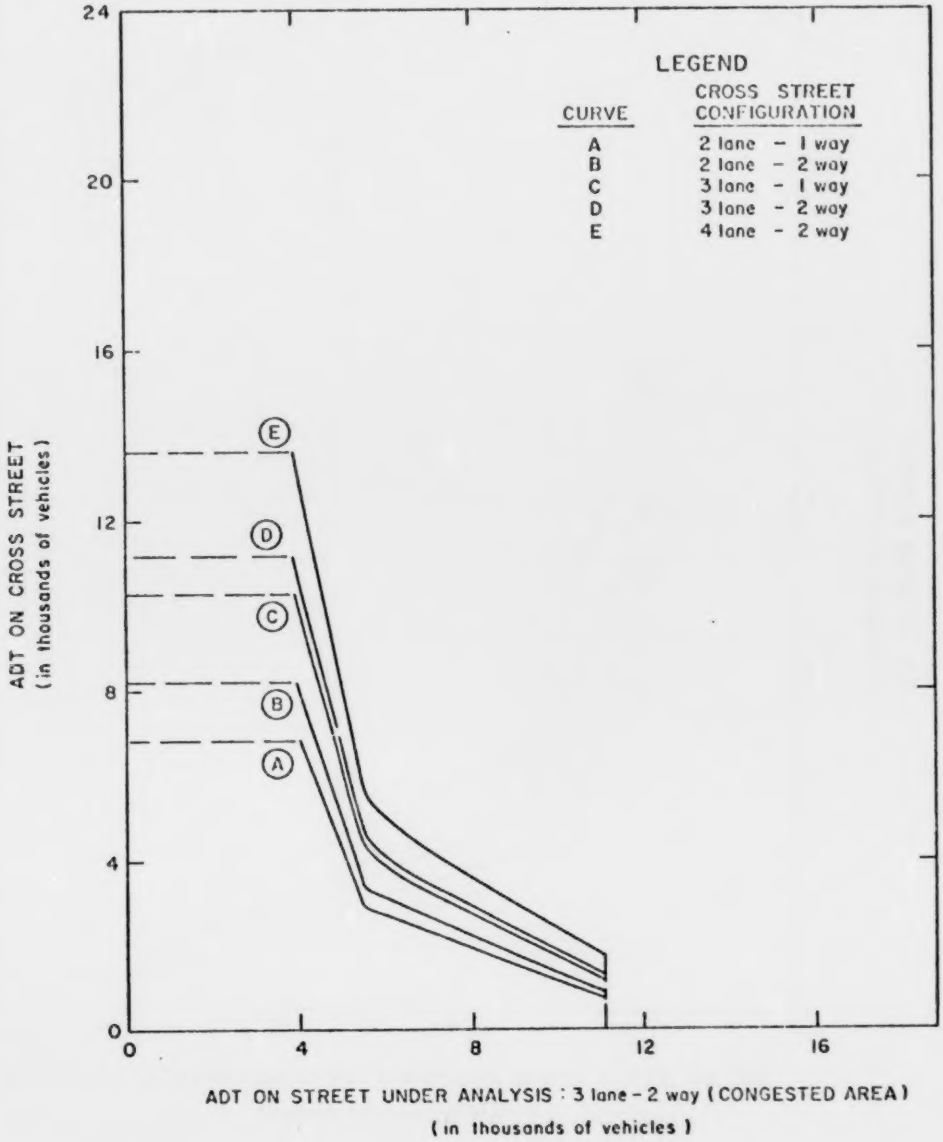


Figure 4. Critical volumes at signalized intersections. Analysis of a 3-lane 2-way street in a congested area.

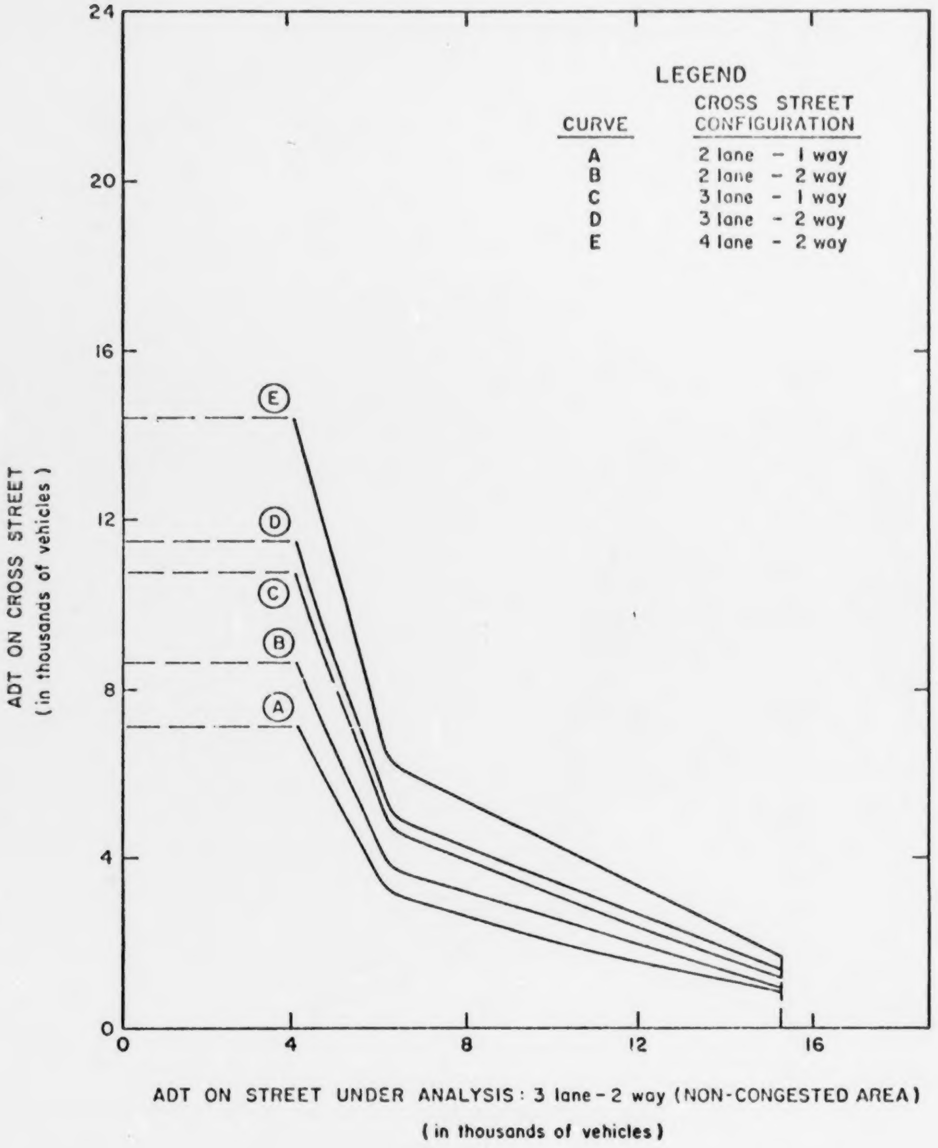


Figure 5. Critical volumes at signalized intersections. Analysis of a 3-lane 2-way street in a noncongested area.

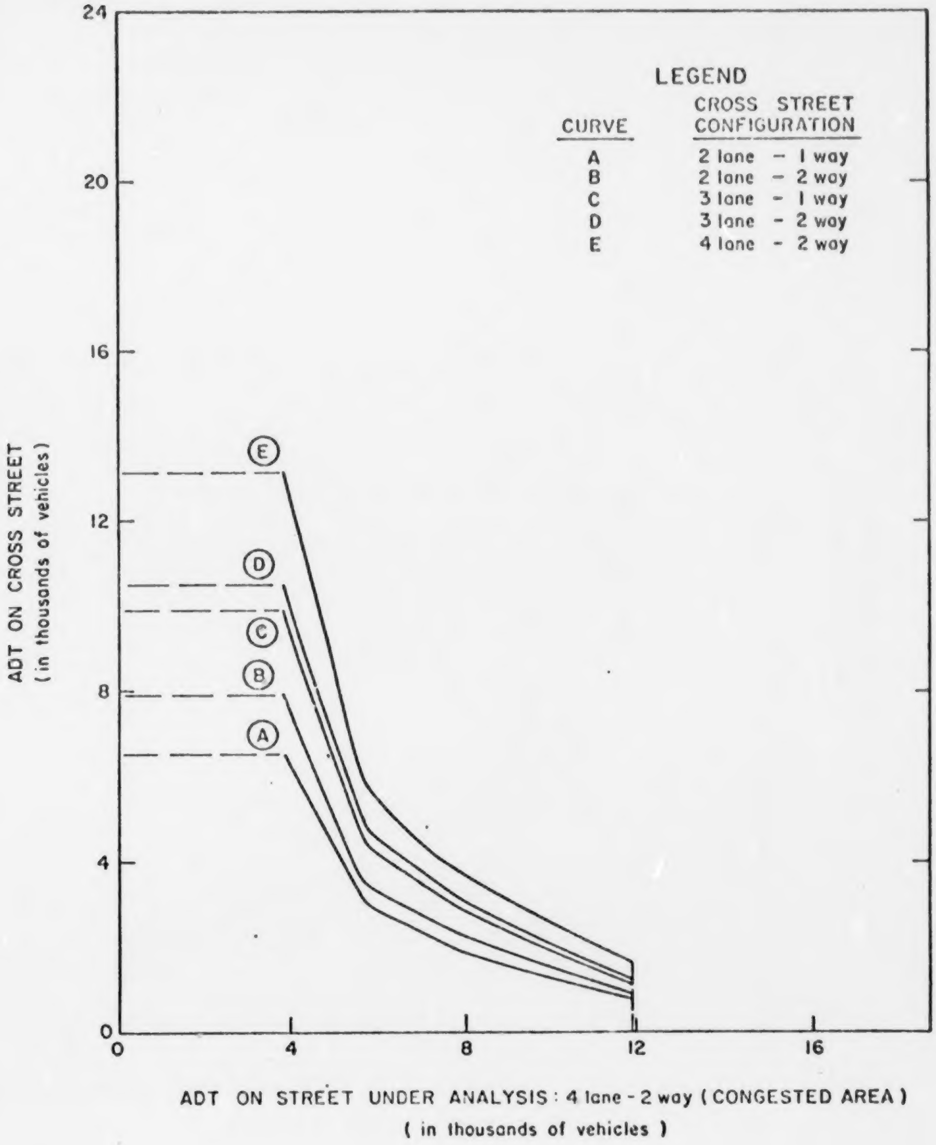


Figure 6. Critical volumes at signalized intersections. Analysis of a 4-lane 2-way street in a congested area.

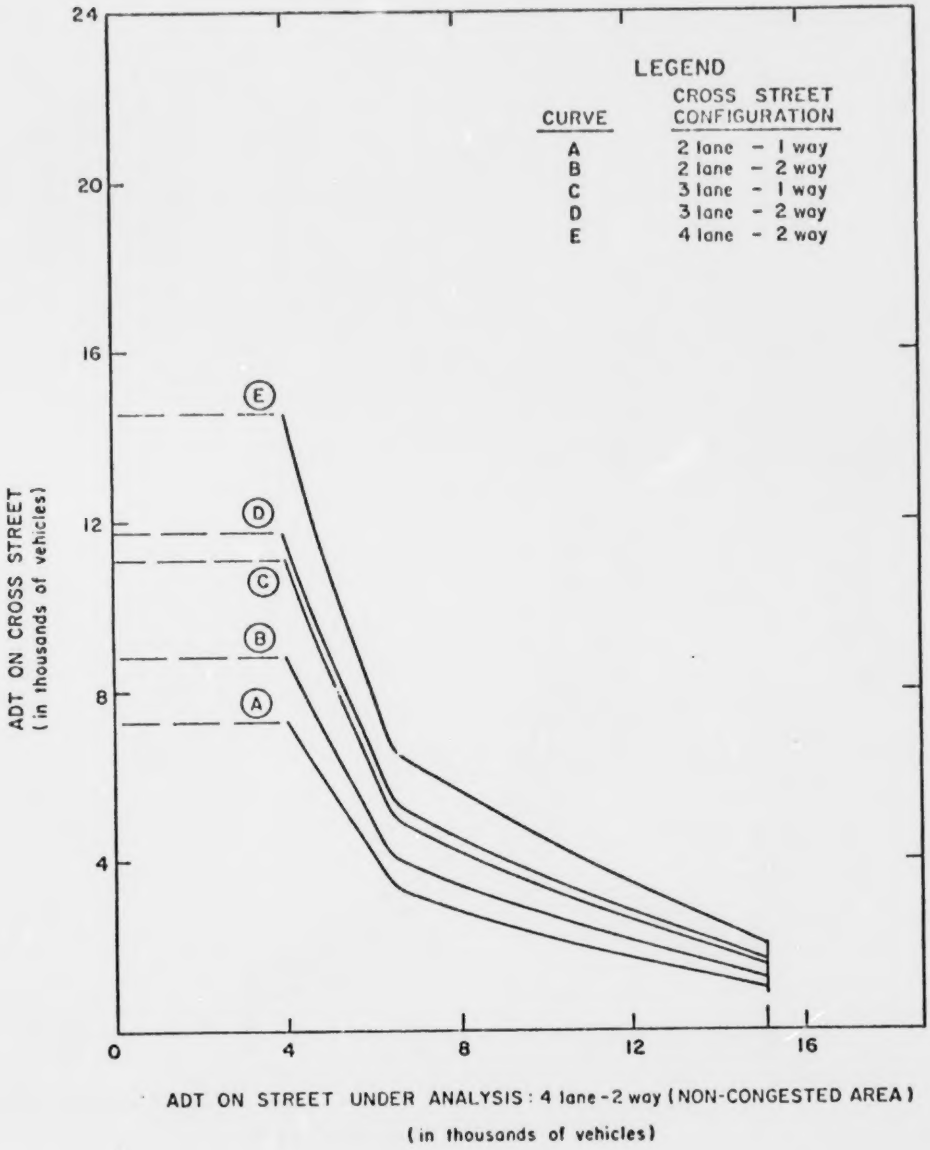


Figure 7. Critical volumes at signalized intersections. Analysis of a 4-lane 2-way street in a noncongested area.

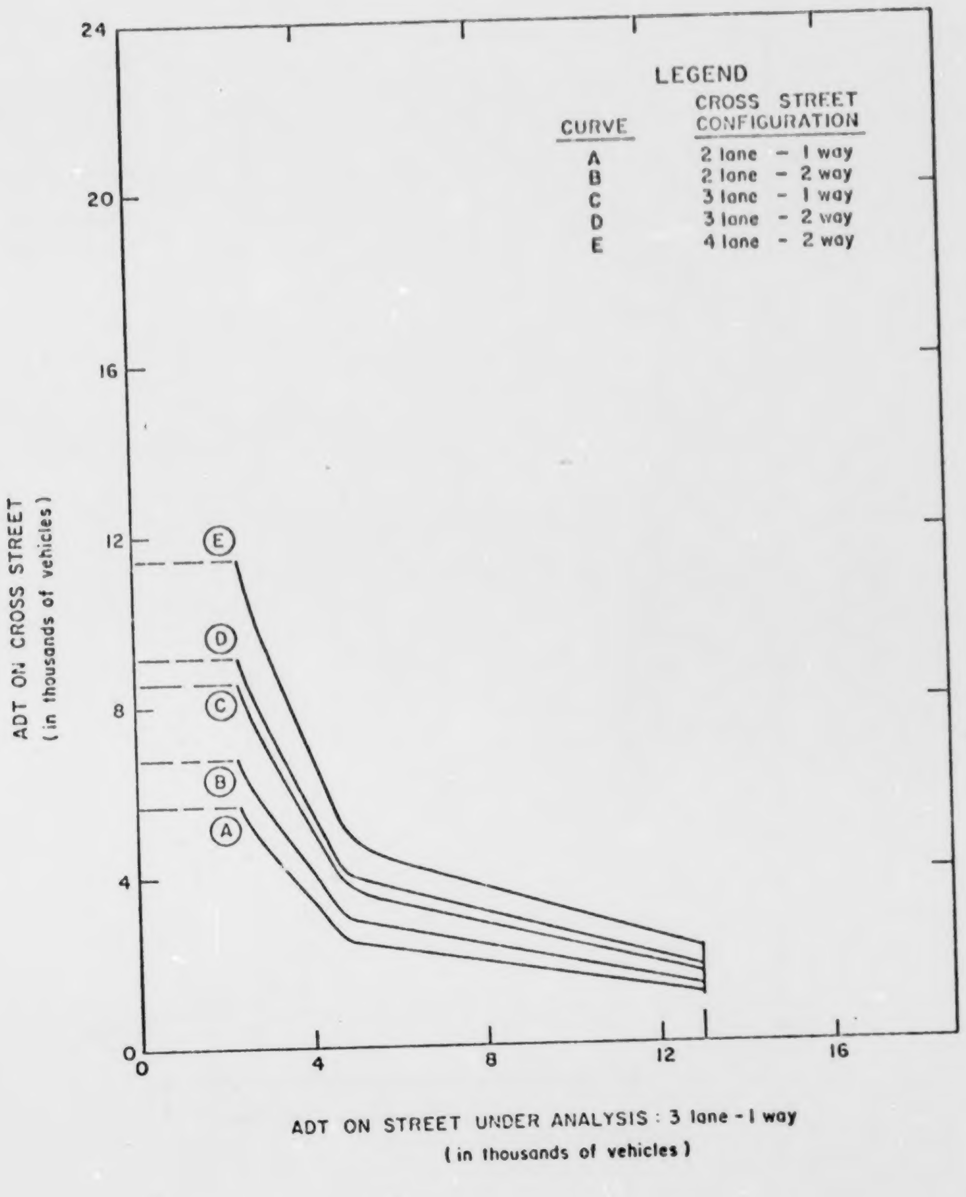


Figure 8. Critical volumes at signalized intersections. Analysis of a 3-lane 1-way street.

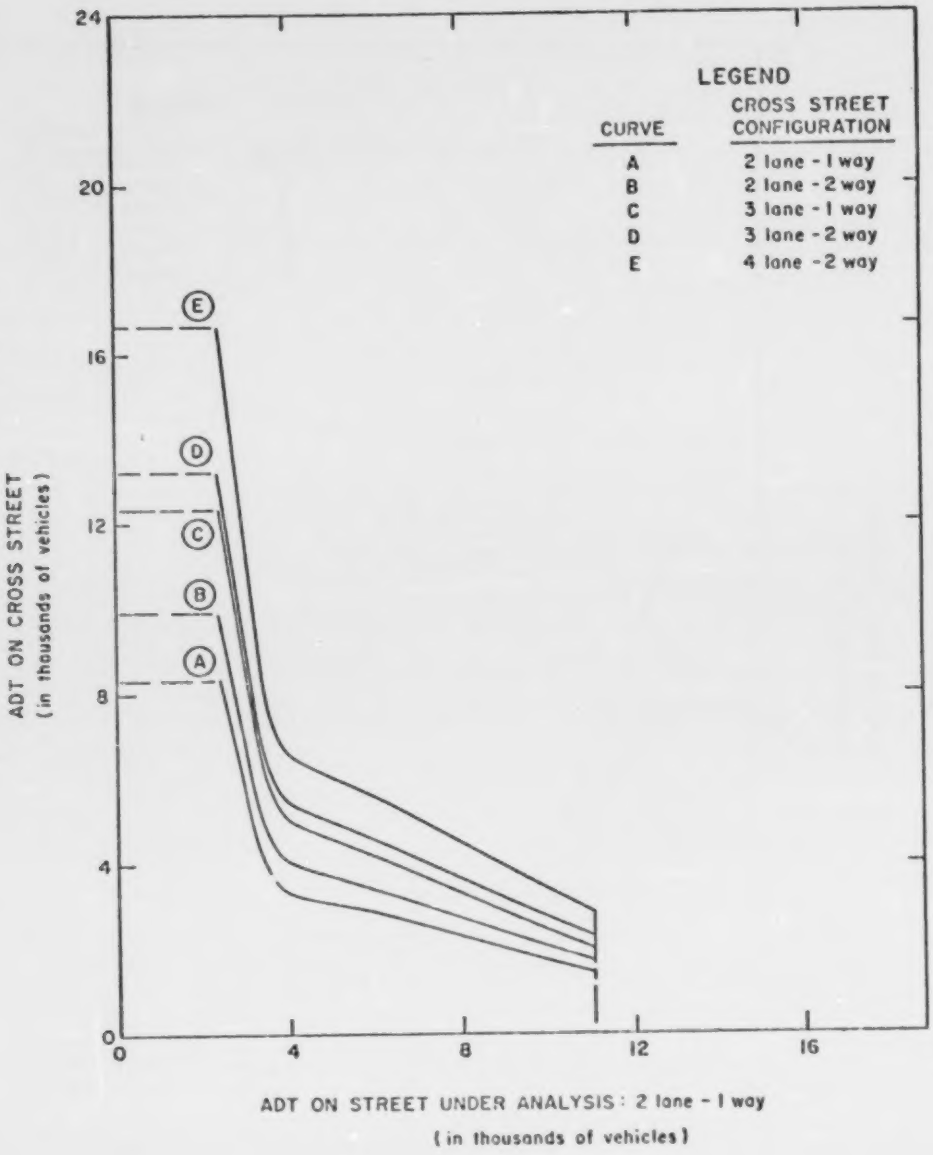


Figure 9. Critical volumes at signalized intersections. Analysis of a 2-lane 1-way street.

b. Uninterrupted Flow - Two types of locations are considered where conditions of uninterrupted flow prevail - these include expressways and arterial streets. One nomograph is presented for each of these two facility-types, as shown by Figures 10 and 11.

Expressways are considered in the nomograph presented in Figure 10. Three separate curves are plotted on this nomograph representing 4-lane, 6-lane, and 8-lane expressways. These curves are plotted as lane capacity (abscissa) versus ADT (ordinate). Each point on the curve represents that combination of lane capacity and 24-hour volume which, under certain assumed conditions, would result in nearby ambient carbon monoxide concentrations of approximately 9.0 ppm. The implication, again, is that for a particular roadway configuration with a certain lane capacity, an ADT equal to or in excess of the "cricital" ADT (shown by the curve on the nomograph) indicates that the location may be a potential hot spot.

The curves in Figure 11 indicate the critical ADT for various configurations of arterial streets. Again, if the actual ADT (estimated for winter 1977-78) exceeds the "critical" ADT, hot spot potential is indicated.

The procedure, then, for using either of the nomographs presented in Figures 10 and 11 is to plot the facilities estimated lane capacity versus its ADT and observe where this plot lies with respect to the curve corresponding to the facility's configuration - if the plot falls on or above the curve, hot spot potential is indicated.

1. Nomographs for Screening Uninterrupted Flow - Nomographs for screening expressways and arterials where conditions of uninterrupted flow prevail are presented as Figures 10 and 11.

c. Nonsignalized Intersections - Ten separate nomographs have been developed for the preliminary screening of nonsignalized intersections. These nomographs are utilized to screen intersection legs controlled by

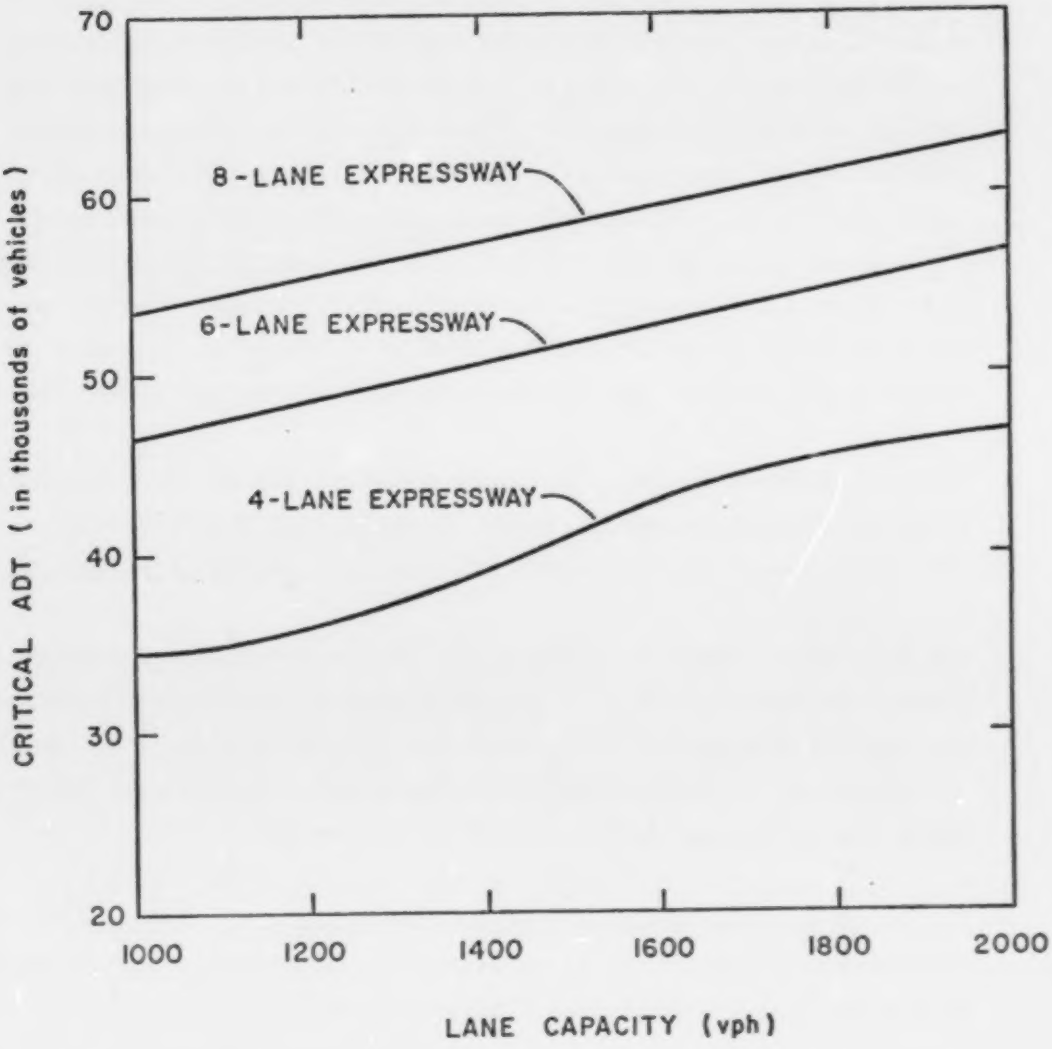


Figure 10. Critical volumes for uninterrupted flow conditions. Analysis of controlled access facilities.

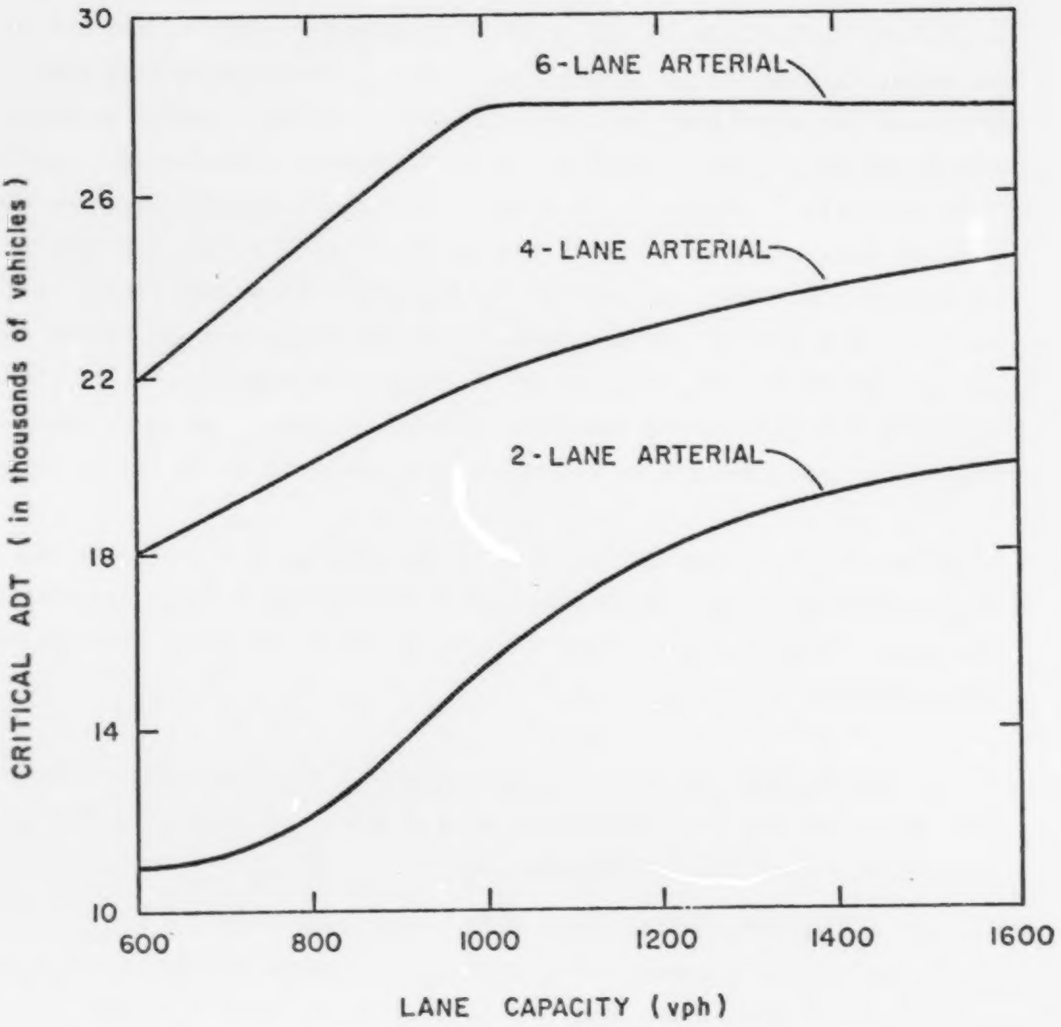


Figure 11. Critical volumes for uninterrupted flow conditions. Analysis of uncontrolled access facilities.

STOP-signs only; the through street legs of a STOP-sign controlled intersection are screened utilizing the nomographs presented for uninterrupted flow.

Several curves are plotted on each nomograph, representing the estimated lane capacity of the major through street. Any point on each curve represents that combination of ADT on the street under analysis and ADT on the major through street (whose lane capacity corresponds with that indicated for the curve) that would result in ambient carbon monoxide concentrations of approximately 9.0 ppm (assuming certain other conditions prevail). Therefore, in order to use these nomographs three elements of data other than the configuration of each street leg must be determined, including (1) the ADT (winter 1977-78) on the street under analysis, (2) the ADT (winter 1977-78) on the major through street, and (3) the estimated lane capacity of the major through street. If, then, the ADT's are plotted and the point lies on or above the curve corresponding to the lane capacity of the major leg, hot spot potential is indicated.

Selection of the nomograph is based on the configuration of both the STOP-sign controlled street being analyzed and the major through street. Again, the curve representing lane capacity is based on the major through street's lane capacity.

1. Nomographs for Screening Nonsignalized Intersections - Nomographs were developed for the preliminary screening of the following STOP-sign controlled street configurations:

- 2-lane, 2-way, 4-way STOP (congested area)
- 2-lane, 2-way, 4-way STOP (noncongested area)
- 2-lane, 2-way minor; 2-lane major (congested area)
- 2-lane, 2-way minor; 2-lane major (noncongested area)
- 2-lane, 2-way minor; 4-lane major (congested area)
- 2-lane, 2-way minor; 4-lane major (noncongested area)
- 4-lane, 2-way minor; 4-lane major (congested area)
- 4-lane, 2-way minor; 4-lane major (noncongested area)

- 2-lane, 1-way minor; 2-lane major
- 2-lane, 1-way minor; 4-lane major

These are presented as Figures 12 through 21, respectively.

3. Preliminary Screening Forms

Presented below are standard forms to be used as work sheets and summary sheets for performing preliminary screening, as well as for reporting the screening of a community. Included are the following:

• Initial Screening Summary Sheet	Form 1
• Preliminary Screening Work Sheet - Signalized Intersections	Form 2
• Preliminary Screening Work Sheet - Uninterrupted Flow	Form 3
• Preliminary Screening Work Sheet - Nonsignalized Intersections	Form 4

Each of these forms will be discussed briefly in the following text.

a. Initial Screening Summary Sheet (Form 1) - This form, as its name implies, is intended to be used for summarizing the initial screening effort for a community. The information to be entered on the sheet includes:

1. A description of each location analyzed - Broadway at Park Street, or Vasser Street between Parson's Road and Kennelworth Drive, for example.
2. The type of location analyzed - either signalized intersection, nonsignalized intersection, freely flowing arterial section, or expressway.
3. Whether or not hot spot potential is indicated by the analysis.

The locations listed are then numbered sequentially. A completed example Initial Screening Summary Sheet is provided on page B-2 of Appendix B.

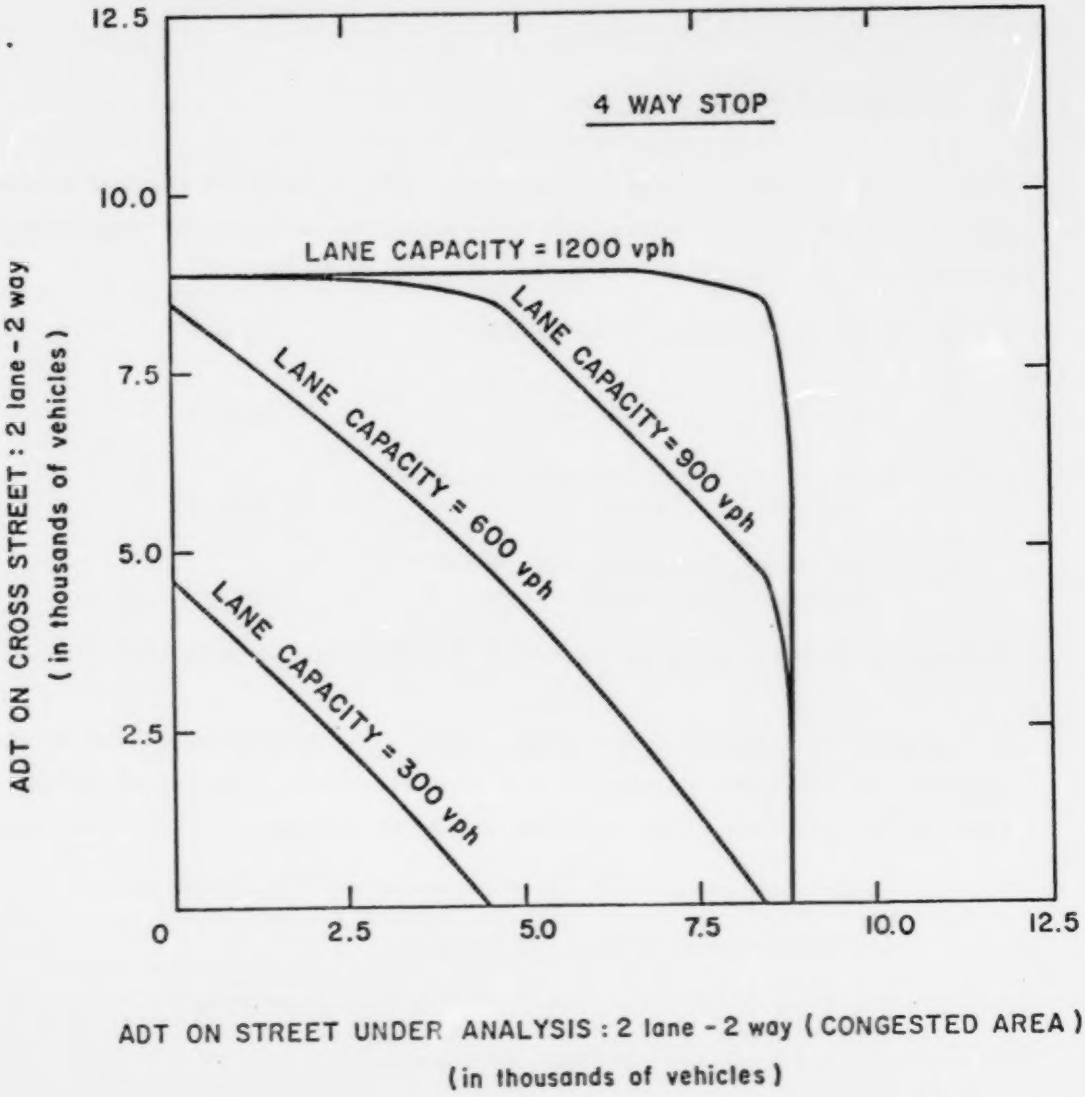


Figure 12. Critical volumes at nonsignalized intersections. Analysis of a 2-lane, 2-way major and minor street intersection under 4-way STOP-sign control in a congested area.

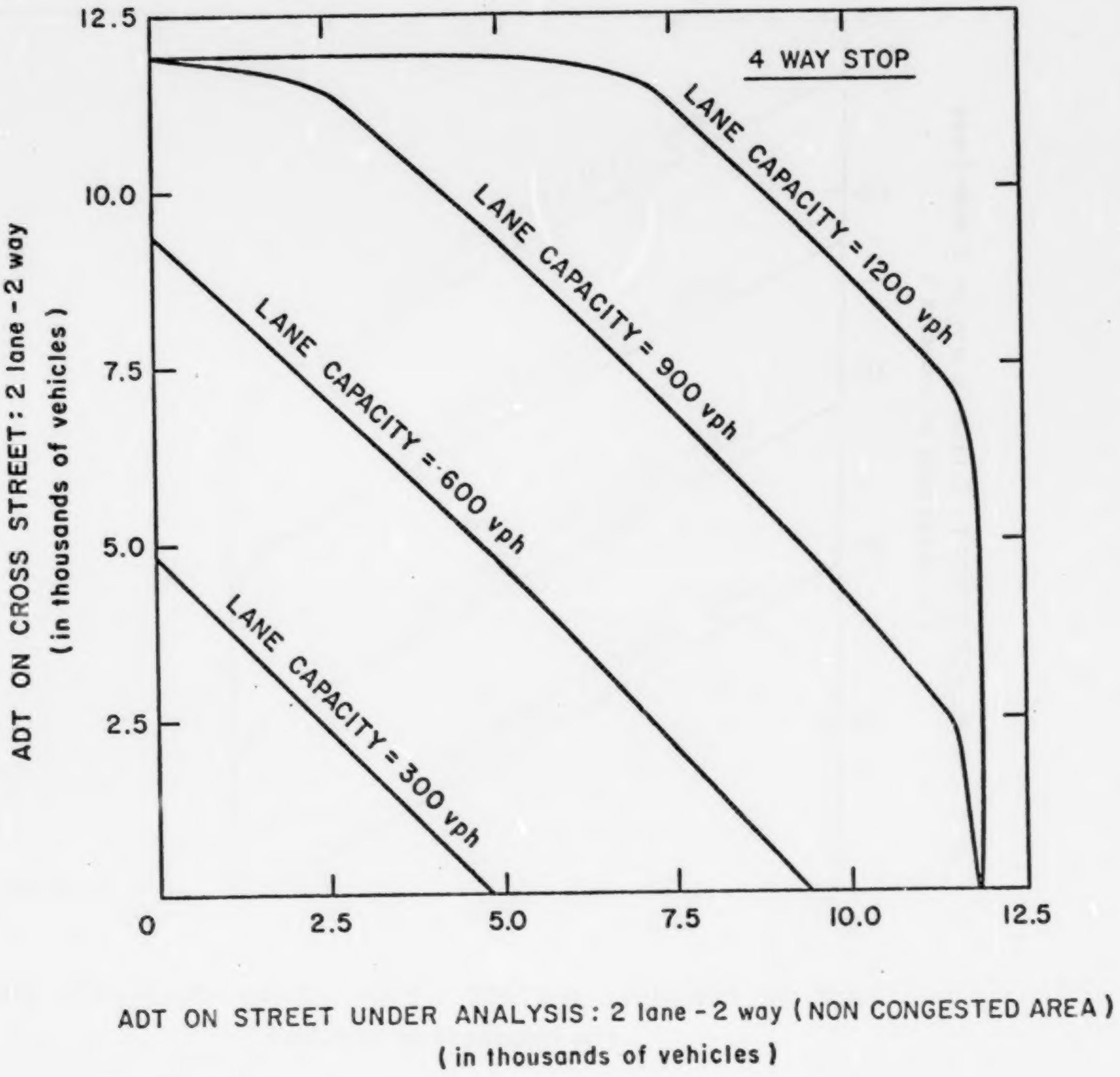


Figure 13. Critical volumes at nonsignalized intersections. Analysis of a 2-lane, 2-way major and minor street intersection under 4-way STOP-sign control in a noncongested area.

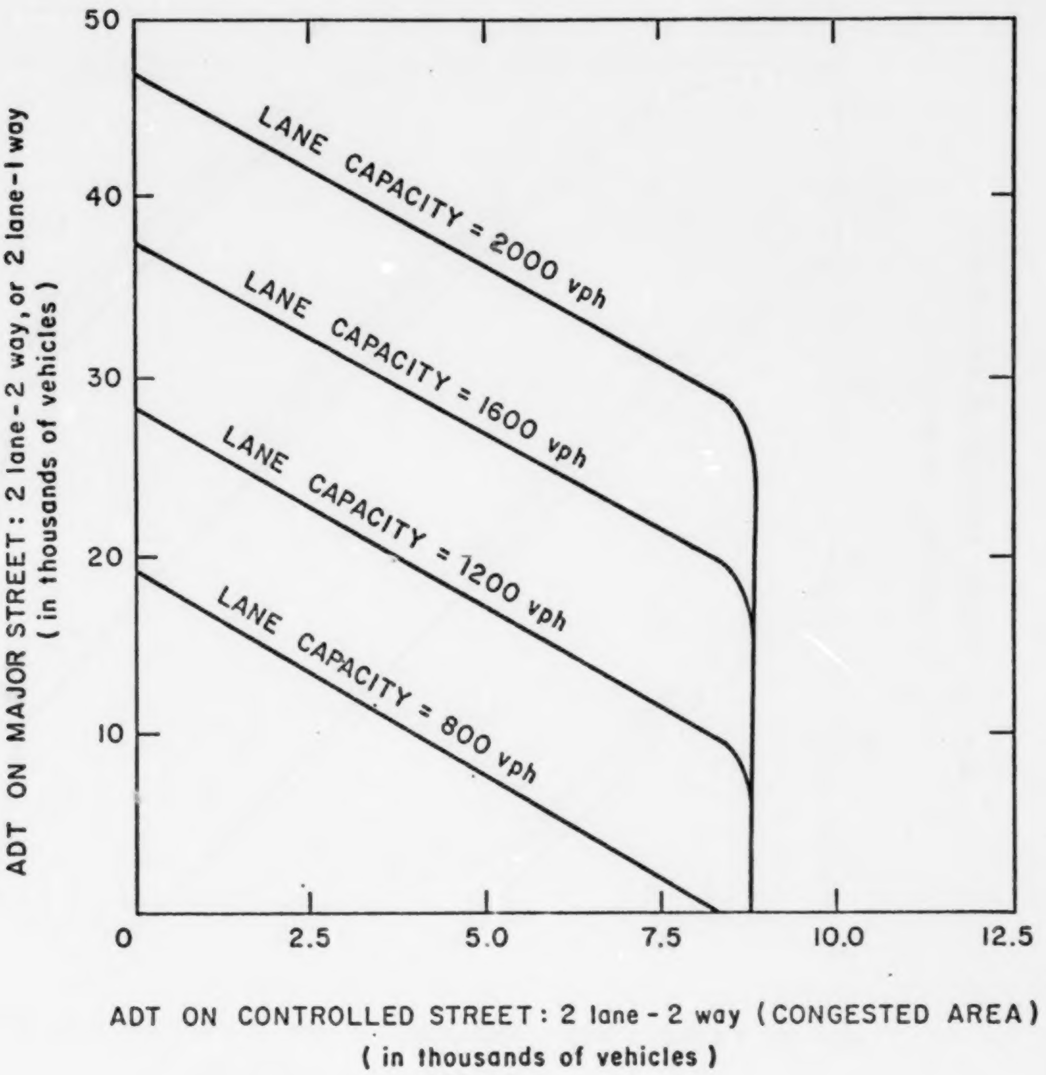


Figure 14. Critical volumes at nonsignalized intersections. Analysis of a 2-lane, 2-way minor street intersecting a 2-lane, 2-way or 2-lane, 1-way major street in a congested area.

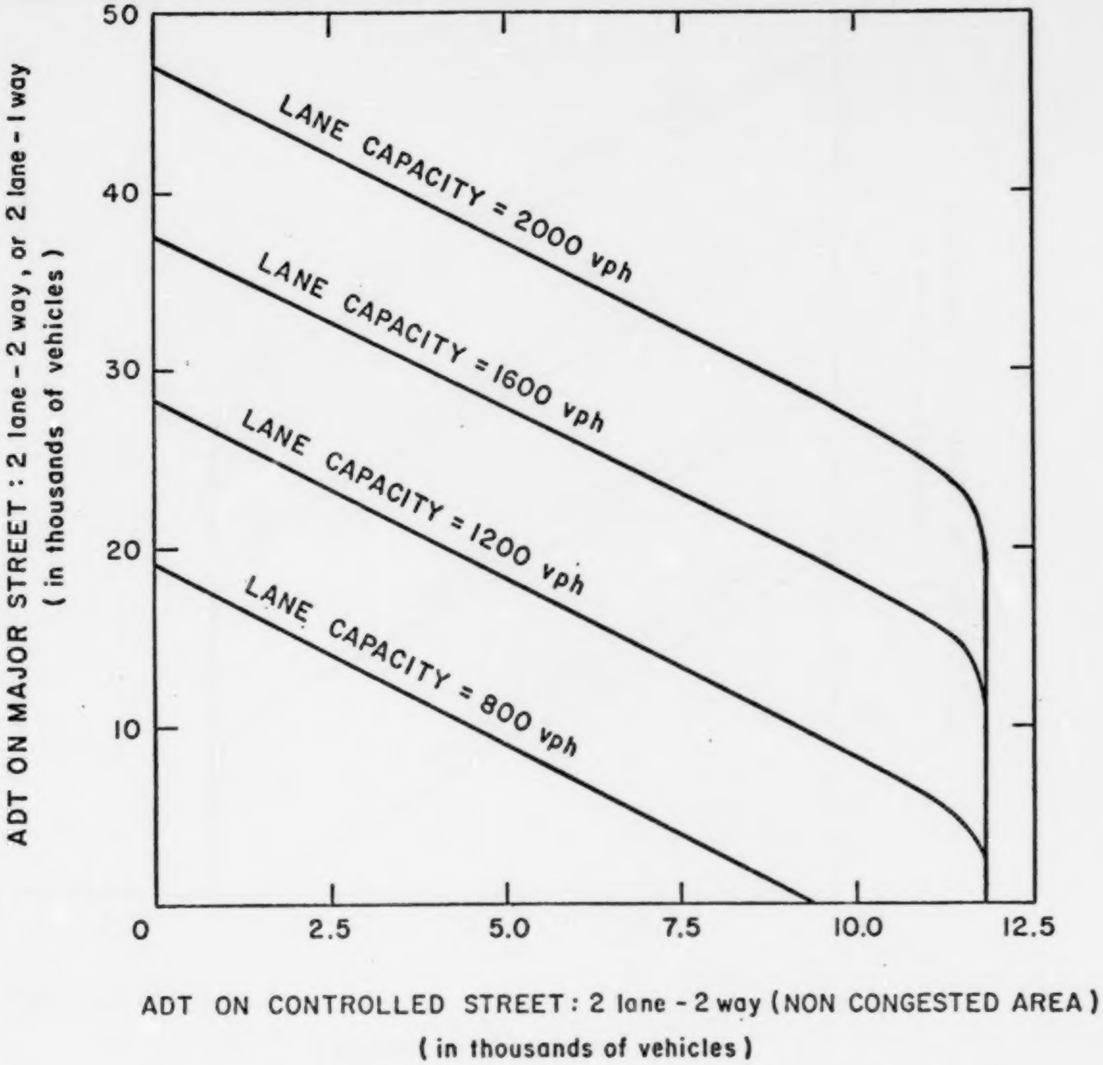


Figure 15. Critical volumes at nonsignalized intersections. Analysis of a 2-lane, 2-way minor street intersecting a 2-lane, 2-way or 2-lane, 1-way major street in a noncongested area.

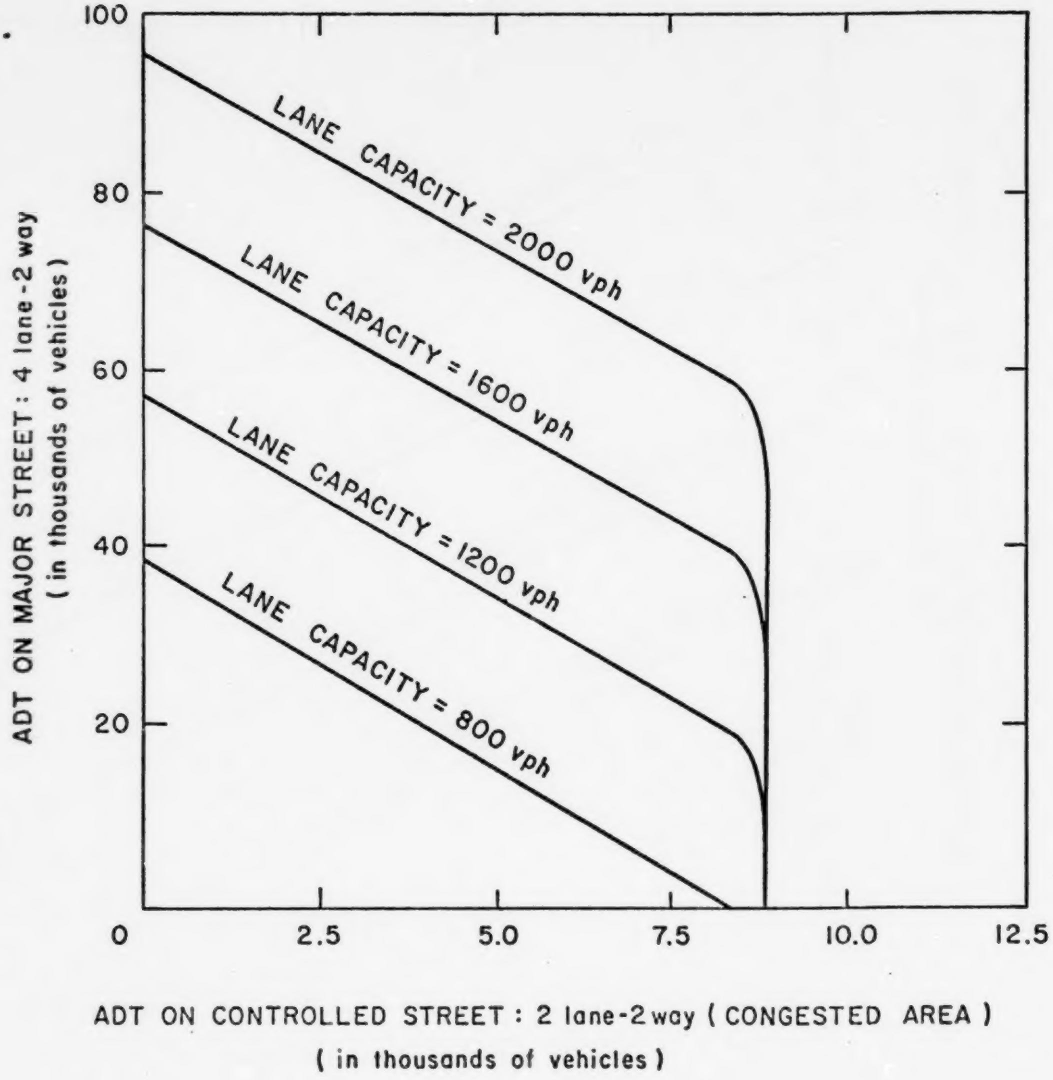


Figure 16. Critical volumes at nonsignalized intersections. Analysis of a 2-lane, 2-way minor street intersecting a 4-lane, 2-way major street in a congested area.

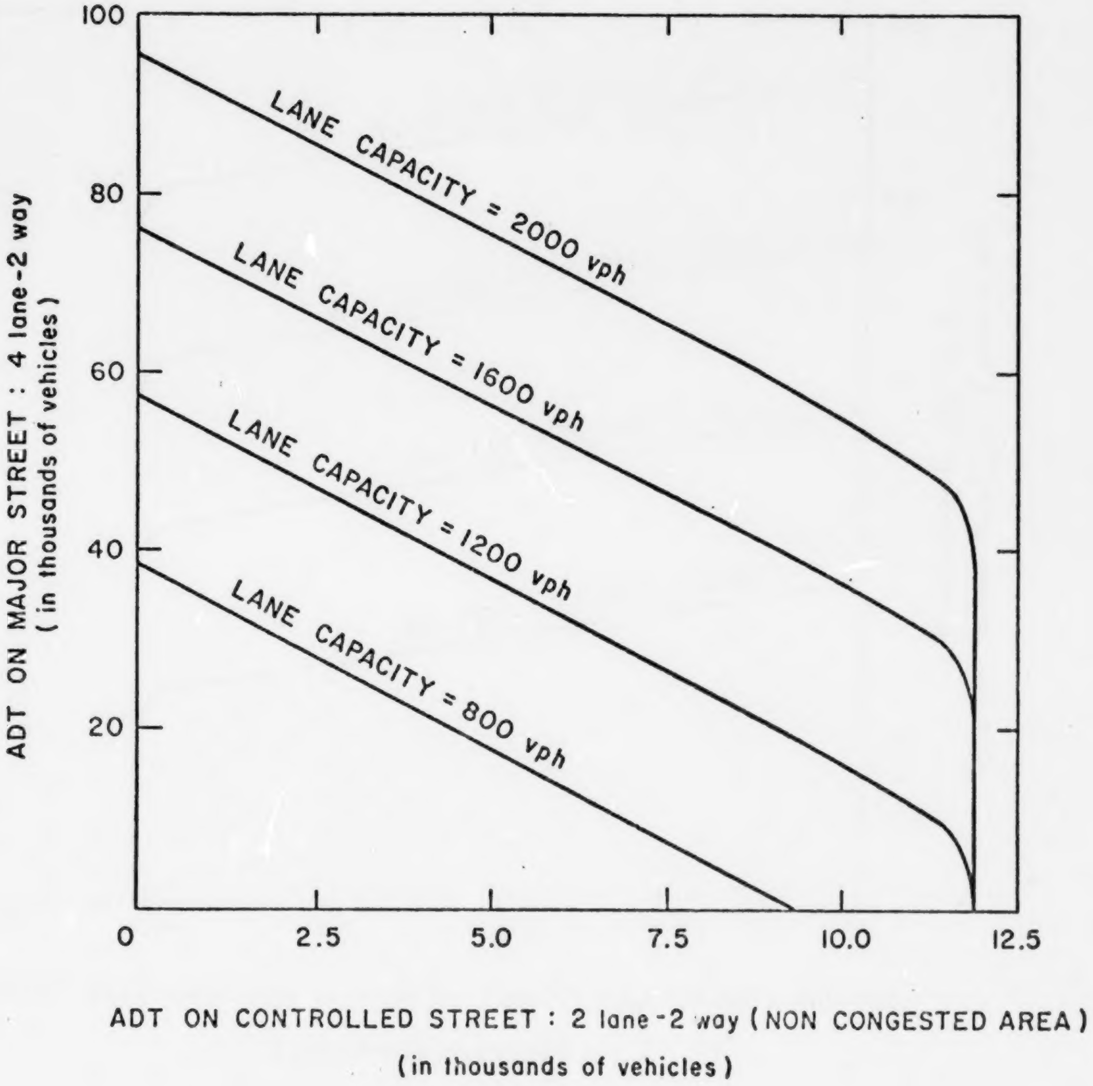


Figure 17. Critical volumes at nonsignalized intersections. Analysis of a 2-lane, 2-way minor street intersecting a 4-lane, 2-way major street in a noncongested area.

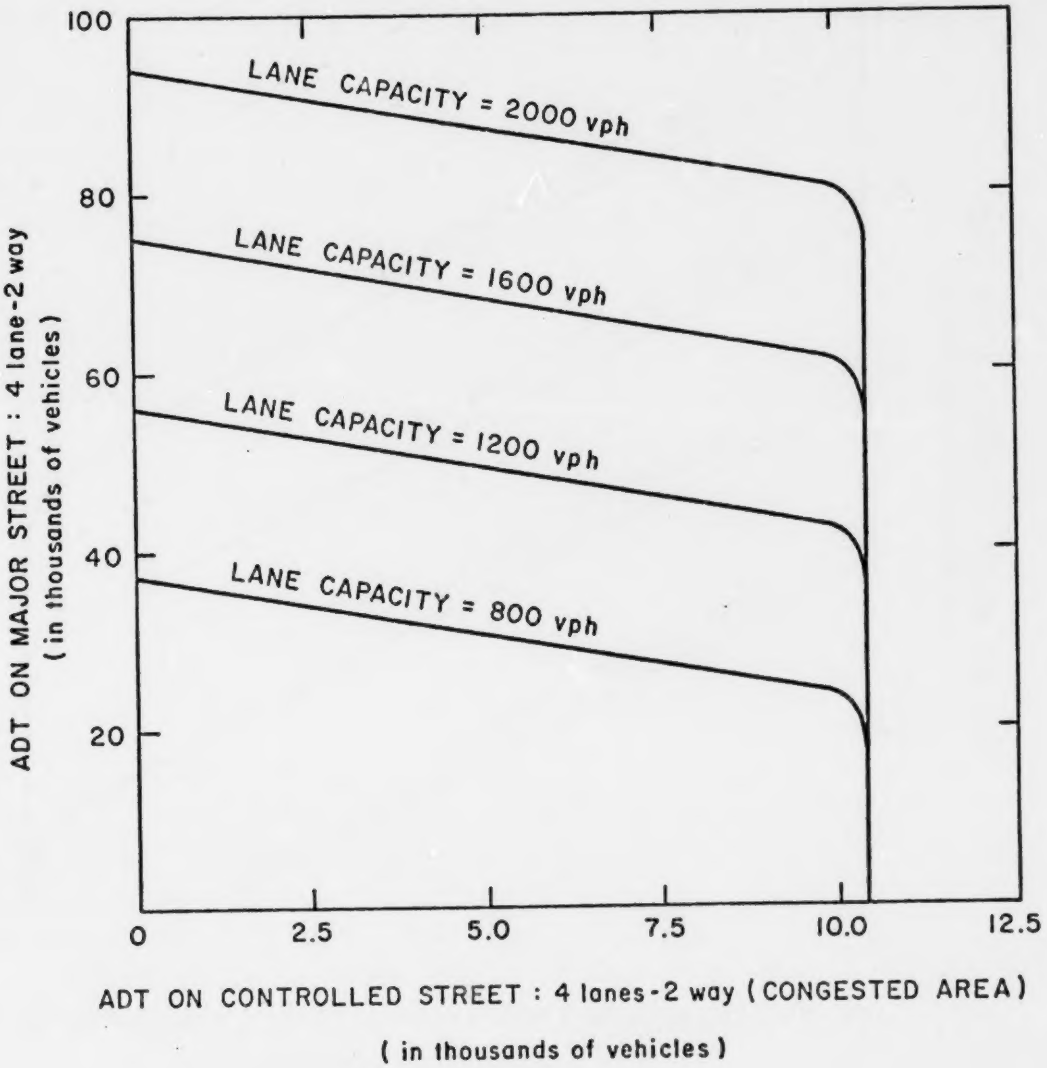


Figure 18. Critical volumes at nonsignalized intersections. Analysis of a 4-lane, 2-way minor street intersecting a 4-lane, 2-way major street in a congested area.

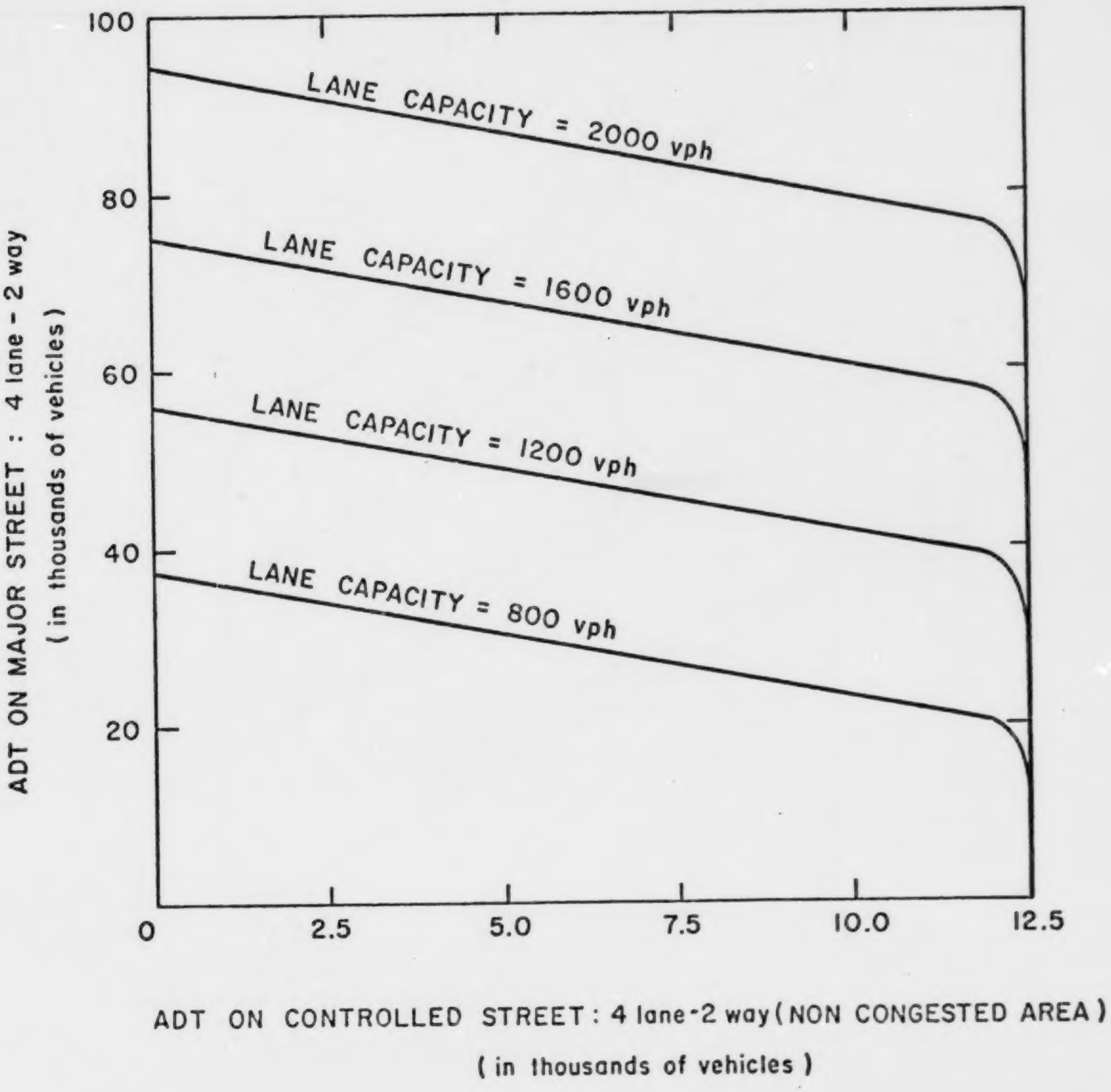


Figure 19. Critical volumes at nonsignalized intersections. Analysis of a 4-lane, 2-way minor street intersecting a 4-lane, 2-way major street in a noncongested area.

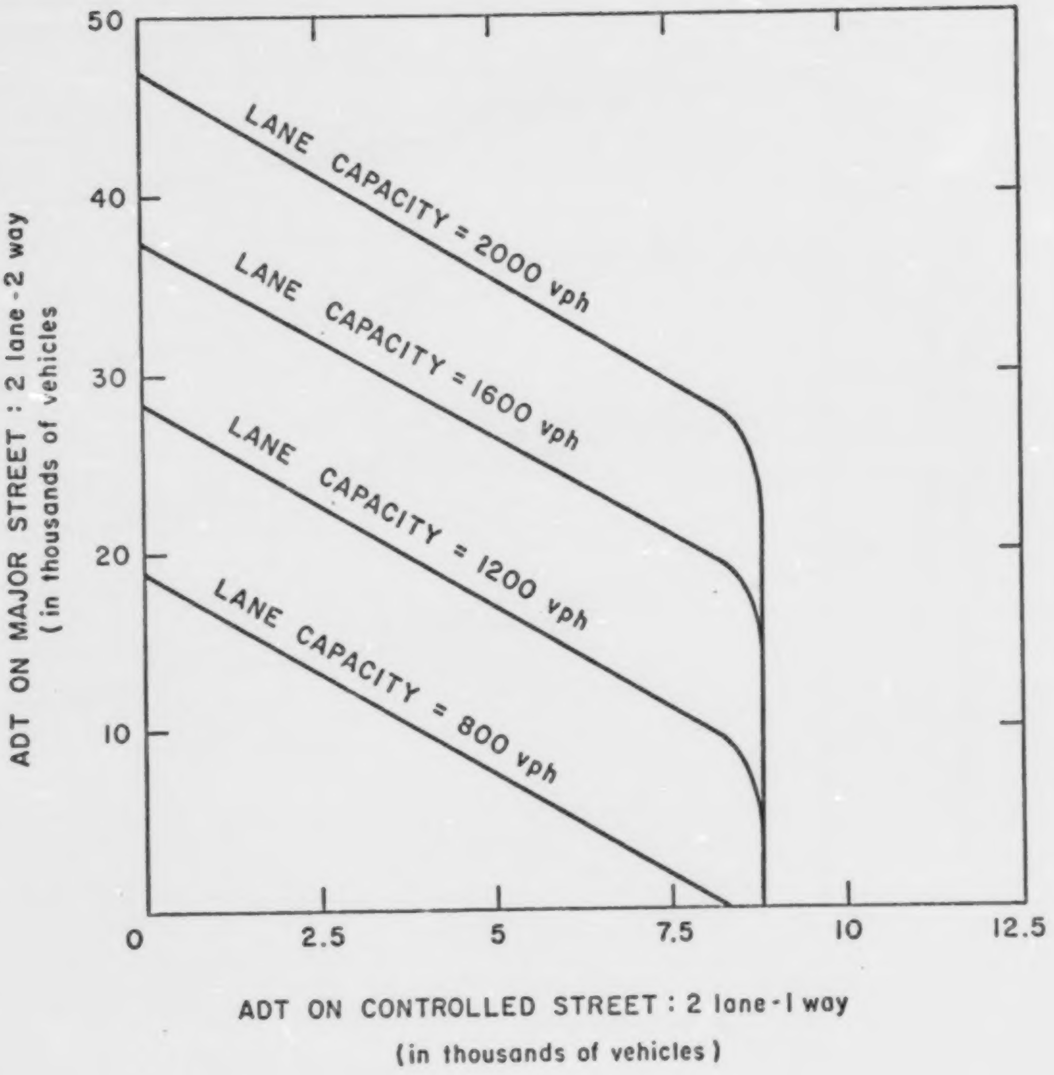


Figure 20. Critical volumes at nonsignalized intersections. Analysis of a 2-lane, 1-way minor street intersecting a 2-lane, 2-way or 2-lane, 1-way major street.

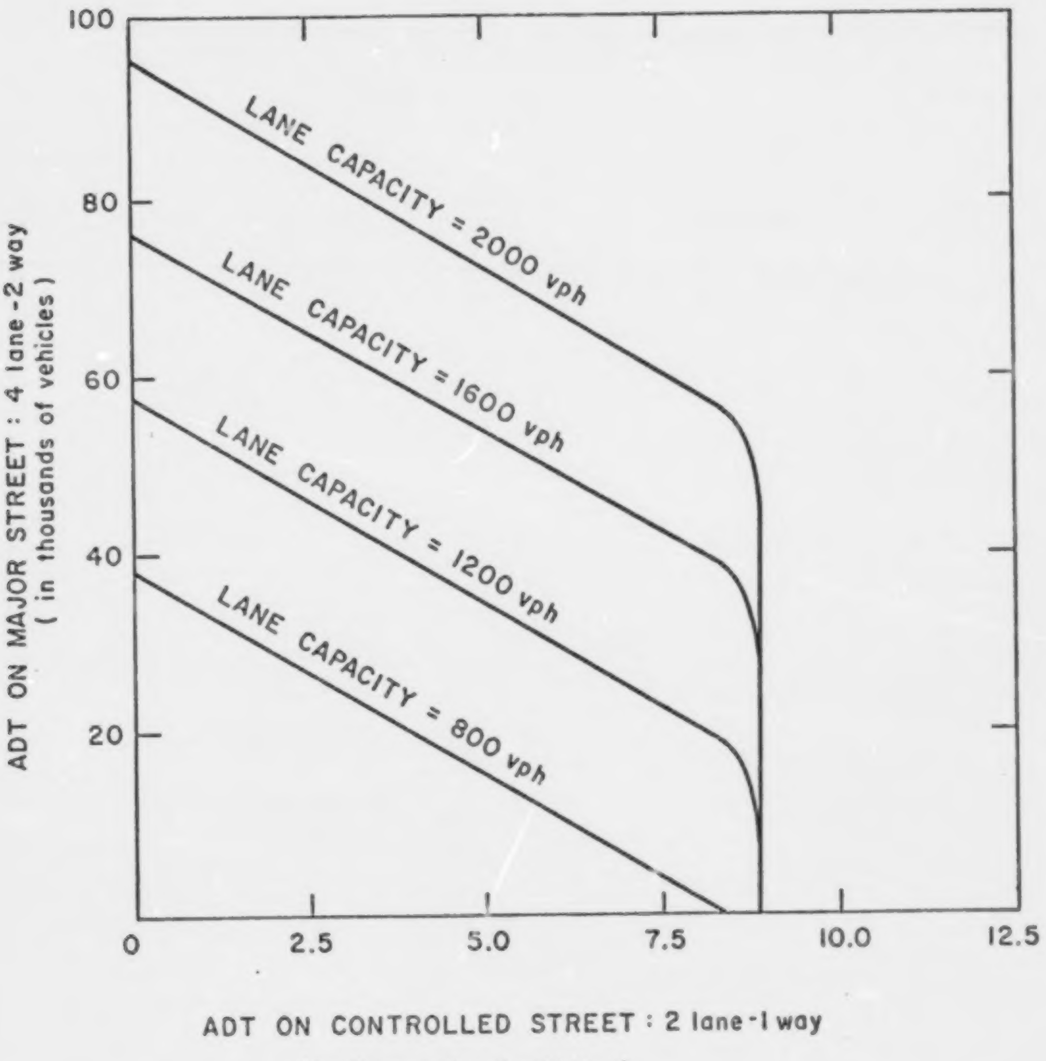


Figure 21. Critical volumes at nonsignalized intersections. Analysis of a 2-lane, 1-way minor street intersecting a 4-lane, 2-way major street

INITIAL SCREENING SUMMARY SHEET

page ___of ___

City/Town: ____________________ State: ____________________

Analysis By: ____________________ (name) ________________ (title) Date: ________

Approved By: ____________________ (name) ________________ (title) Date: ________

Location	Type	Hot Spot Indicated or Detailed Analysis Required	
		Yes	No

Form 1

PRELIMINARY SCREENING WORK SHEET- SIGNALIZED INTERSECTIONS

page ___ of ___

City/Town: ____________________ State: ____________________

Analysis By: ____________________ (name) _______________ (title) Date: __________

Approved By: ____________________ (name) _______________ (title) Date: __________

Part I Location: ____

Part II Congested Area? ____ Yes; ____ No

Part III Complex Intersection or Special Case? ____ Yes; ____ No; If yes, enter location on Initial Screening Summary Sheet and proceed to next intersection; if no, proceed with Part IV.

Part IV Analyze each leg seperately on the form, below.

Leg under analysis			Cross-street data							
			Street: ________ Leg: ____				Street: ________ Leg: ____			
a Designation	b Adjusted ADT (1977-78)	c Configuration	d Adjusted ADT (1977-78)	e Configuration	f Figure/ curve used	g Hot spot indicated?	h Adjusted ADT (1977-78)	i Configuration	j Figure/ curve used	k Hot spot indicated?
			Street: ________ Leg: ____				Street: ________ Leg: ____			

Part I Location: ____

Part II Congested Area? ____ Yes; ____ No

Part III Complex Intersection or Special Case? ____ Yes; ____ No; If yes, enter location on Initial Screening Summary Sheet and proceed to next intersection; if no, proceed with Part IV.

Part IV Analyze each leg seperately on the form, below.

Leg under analysis			Cross-street data							
			Street: ________ Leg: ____				Street: ________ Leg: ____			
a Designation	b Adjusted ADT (1977-78)	c Configuration	d Adjusted ADT (1977-78)	e Configuration	f Figure/ curve used	g Hot spot indicated?	h Adjusted ADT (1977-78)	i Configuration	j Figure/ curve used	k Hot spot indicated?
			Street: ________ Leg: ____				Street: ________ Leg: ____			

Form 2

Reproduced from best available copy.

PRELIMINARY SCREENING WORK SHEET – UNINTERRUPTED FLOW

City/Town: ____________________ State: ____________ page ___ of ___

Analysis By: ____________________ ____________________ Date: __________
(name) (title)

Approved By: ____________________ ____________________ Date: __________
(name) (title)

a Facility	b Location	c Adjusted ADT (1977-78)	d Configuration	e Est. lane capacity	f Hot Spot indicated?

Form 3

PRELIMINARY SCREENING WORK SHEET – NONSIGNALIZED INTERSECTIONS

page ___of ___

City/Town: ____________________ State: ____________________

Analysis By: ____________________ (name) ________________ (title) Date: ________

Approved By: ____________________ (name) ________________ (title) Date: ________

Part I Location: ______________________________

Part II Analyze each cross street leg on the form, below:

Through street data				Minor cross street data							
				Street:__________ Leg_____				Street:__________ Leg_____			
a Adjusted ADT (1977-78)	b Configuration	c Est. lane capacity	d Hot Spot indicated?	e Adjusted ADT (1977-78)	f Configuration	g Figure/curve used	h Hot Spot indicated?	i Adjusted ADT (1977-78)	j Configuration	k Figure/curve used	l Hot Spot indicated?

Part I Location: ______________________________

Part II Analyze each cross street leg on the form, below:

Through street data				Min[illegible]eet data							
				Street:__________ Leg[illegible]				[illegible]treet:__________ Leg_____			
a Adjusted ADT (1977-78)	b Configuration	c Est. lane capacity	d Hot Spot indicated?	e Adjusted ADT (1977-78)	f Configuration	g Figure/curve used	[illegible] Hot Spot indicated?	i Adjusted ADT (1977-78)	j Configuration	k Figure/curve used	l Hot Spot indicated?

Part I Location: ______________________________

Part II Analyze each cross street leg on the form, below:

Through street data				Minor cross street data							
				Street:__________ Leg_____				Street:__________ Leg_____			
a Adjusted ADT (1977-78)	b Configuration	c Est. lane capacity	d Hot Spot indicated?	e Adjusted ADT (1977-78)	f Configuration	g Figure/curve used	h Hot Spot indicated?	i Adjusted ADT (1977-78)	j Configuration	k Figure/curve used	l Hot Spot indicated?

Part I Location: ______________________________

Part II Analyze each cross street leg on the form, below:

Through street data				Minor cross street data							
				Street:__________ Leg_____				Street:__________ Leg_____			
a Adjusted ADT (1977-78)	b Configuration	c Est. lane capacity	d Hot Spot indicated?	e Adjusted ADT (1977-78)	f Configuration	g Figure/curve used	h Hot Spot indicated?	i Adjusted ADT (1977-78)	j Configuration	k Figure/curve used	l Hot Spot indicated?

Form 4

b. Preliminary Screening Work Sheet - Signalized Intersections (Form 2) - This form provides space for the analysis of two separate intersections. To complete this form the intersecting streets' names are entered in Part I and it is indicated whether or not the intersection is located in a congested area, in Part II (guidance for making this determination is provided in Section IV.H). In Part III, it is indicated whether or not the location should be considered a complex intersection or a special case (see Section IV.H for guidance in making this decision). For locations that are not considered complex intersections or special cases, the actual screening is performed in Part IV.

In Part IV each leg of the intersection is analyzed separately. Under the main column heading "Leg Under Analysis," the leg designation (name and orientation such as Amity Road, south leg), the adjusted average daily traffic volumes, and the roadway configuration (for example, 4-lane, 2-way) are entered.

Under the other main column heading of "Cross-Street Data," the appropriate data elements for the cross street leg having the highest traffic volume are recorded. Then, utilizing the appropriate nomograph and curve, a determination of hot spot potential is made and recorded. If the configuration of the other leg of the cross street is different from the leg previously used in the analysis, the procedure is repeated using the data for the second cross-street leg and the appropriate nomograph and curve. Note that columns f and j provide space to record the figure number and curve designation for the nomograph used to perform the screening. Two completed sample forms appear on pages B-4 and B-5 of Appendix B.

c. Preliminary Screening Work Sheet - Nonsignalized Intersections (Form 3) - This form allows for the analysis of four nonsignalized intersections. In the first major column, "Through Street Data," the through street is analyzed in the same fashion as for uninterrupted flow conditions. Each leg of the controlled cross street is then analyzed in the two columns under the heading of "Cross Street Data." A completed sample form is provided on page B-6 of Appendix B.

d. Preliminary Screening Work Sheet - Uninterrupted Flow (Form 4) - Up to 30 locations where conditions of interrupted flow prevail can be analyzed on each of these forms. The data required include the facility name; a description of its location; its volume, configuration, and capacity; and finally, whether or not hot spot potential is indicated. A sample completed form is provided on page B-7 of Appendix B.

4. Performing Preliminary Screening

Detailed instructions on performing preliminary screening are provided in Section II.C which follows. Prior to this detailed discussion it may be helpful to look at the process in general terms; this can be best illustrated by a flow diagram as shown in Figure 22.

As can be seen from the flow diagram, the first steps involve compiling the required data. Once this has been completed, screening begins. First, all signalized intersections are screened, followed by locations where uninterrupted flow prevails, and finally, nonsignalized intersections. The importance of the order of analysis becomes apparent in the following detailed discussion.

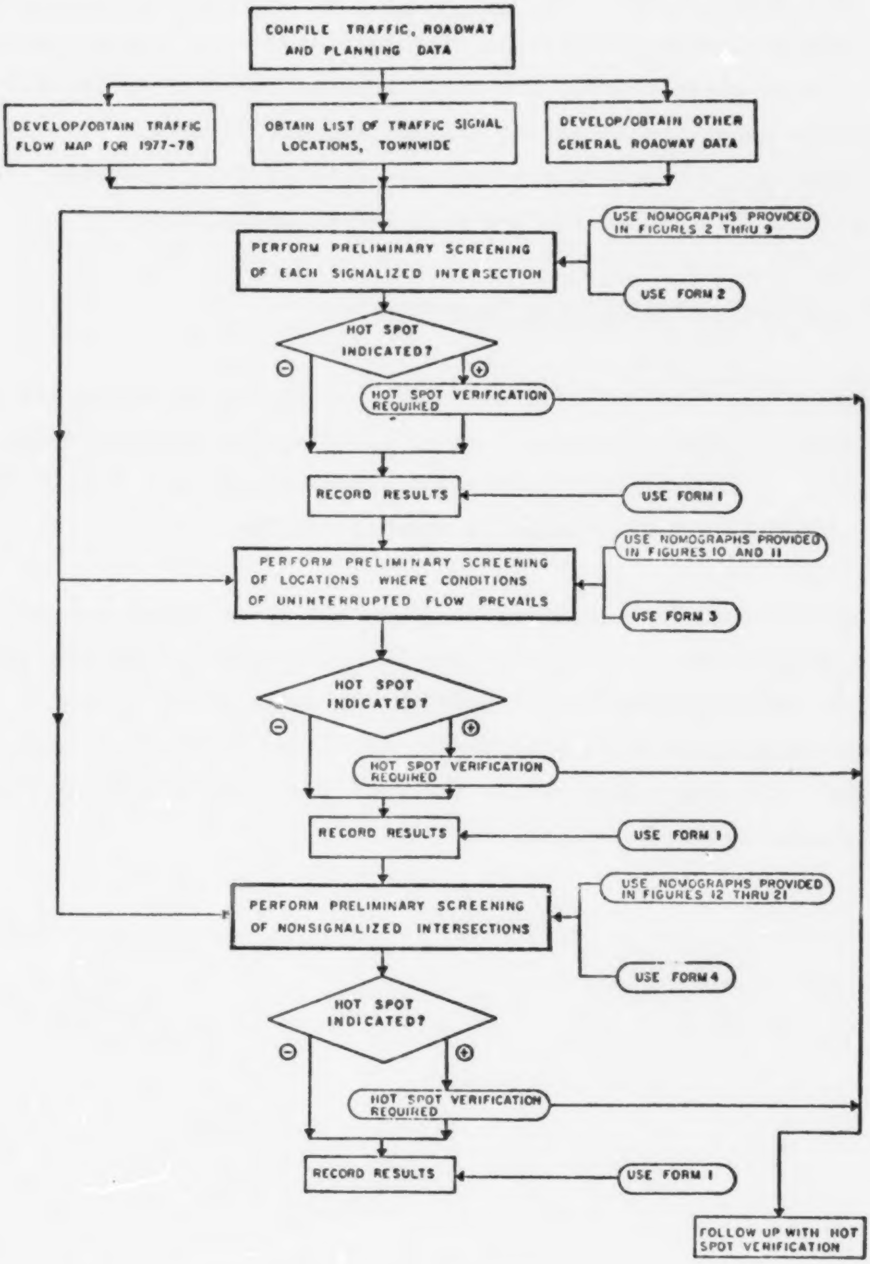

COMPILE TRAFFIC, ROADWAY AND PLANNING DATA
DEVELOP/OBTAIN TRAFFIC FLOW MAP FOR 1977-78
OBTAIN LIST OF TRAFFIC SIGNAL LOCATIONS, TOWNWIDE
DEVELOP/OBTAIN OTHER GENERAL ROADWAY DATA
PERFORM PRELIMINARY SCREENING OF EACH SIGNALIZED INTERSECTION
USE NOMOGRAPHS PROVIDED IN FIGURES 2 THRU 9
USE FORM 2
HOT SPOT INDICATED?
⊖
⊕
HOT SPOT VERIFICATION REQUIRED
RECORD RESULTS
USE FORM 1
PERFORM PRELIMINARY SCREENING OF LOCATIONS WHERE CONDITIONS OF UNINTERRUPTED FLOW PREVAILS
USE NOMOGRAPHS PROVIDED IN FIGURES 10 AND 11
USE FORM 3
HOT SPOT INDICATED?
⊖
⊕
HOT SPOT VERIFICATION REQUIRED
RECORD RESULTS
USE FORM 1
PERFORM PRELIMINARY SCREENING OF NONSIGNALIZED INTERSECTIONS
USE NOMOGRAPHS PROVIDED IN FIGURES 12 THRU 21
USE FORM 4
HOT SPOT INDICATED?
⊖
⊕
HOT SPOT VERIFICATION REQUIRED
RECORD RESULTS
USE FORM 1
FOLLOW UP WITH HOT SPOT VERIFICATION

Figure 22. Process flow diagram for the preliminary screening of carbon monoxide hot spots

C. DETAILED INSTRUCTIONS FOR PRELIMINARY SCREENING

The following presents detailed instructions for performing preliminary screening based on utilizing the data, nomographs, forms, and general procedure discussed in the previous portion of this section. Included are step-by-step instructions for the three subtasks (analysis of signalized intersections, uninterrupted flow, and nonsignalized intersections) involved in the preliminary screening process.

1. Subtask 1-a: Screening Signalized Intersections

a. Step 1 - Prepare a townwide traffic flow map depicting the highest monthly projected ADT's on the street network for the winter months (November through March) of 1977-1978. This should be presented on a suitable base map (or maps) at a scale of between 1 inch = 1,000 feet and 1 inch = 3,000 feet; insets at a larger scale should be used, as appropriate, for congested areas. Volumes should be included for all principal streets including, as a minimum, all streets and highways on the Federal Aid System and on all street sections controlled by traffic signals.

b. Step 2 - Determine the locations where traffic signals are utilized to control traffic.

c. Step 3 - Determine the configuration (i.e., the number of approach and departure lanes) of each leg for all signalized intersections. Also, a determination should be made as to whether each intersection is located in a congested or noncongested area, and whether any of the locations should be classified as complex intersections or special cases.*

---

*See Definitions in Section IV.H.

d. Step 4 - Enter appropriate data for each signalized intersection on the Preliminary Screening Work Sheet - Signalized Intersections (see Section II.B.3), as follows:

1. Part I:
    a. Enter the location (e.g., Main Street at Naussam Road).
2. Part II:
    a. Record whether or not the location is generally within a congested area (see Section IV.H).
3. Part III:
    a. Record whether or not the location should be considered a complex intersection or special case. If it is either a complex intersection or a special case, enter the location on the Initial Screening Summary Sheet (see Section II.B.3) and proceed to the next intersection.
    b. If the location is neither complex nor a special case, proceed to Part IV.
4. Part IV: Each leg of the intersection is analyzed as follows:
    a. Enter the leg designation (e.g., Main Street, south leg) in column a. It is important to identify the particular leg being considered (e.g., Main Street, south leg).
    b. Enter the adjusted ADT (winter 1977-78) in column b.
    c. Enter the configuration (e.g., 2-lane, 1-way) of the leg in column c.
    d. Enter the name and orientation (e.g., Main Street, east leg) of each cross street leg on the line above columns d through k.
    e. For the first leg of the cross street:
        1. Enter the adjusted ADT (winter 1977-78) in column d.
        2. Enter its configuration (e.g., 2-lane, 1-way) in column e.

3. Enter the figure number and curve to be used for screening in column f (see Section II.B.2 for instructions on the selection of figures and curves).

4. Using the figure and curve noted in column f, determine whether or not hot spot potential exists; record this determination in column g.

f. For the other leg of the cross street:

1. Enter the adjusted ADT (winter 1977-78) in column h.

2. Enter its configuration (e.g., 2-lane, 2-way) in column i.

3. Enter the figure number and curve to be used for screening in column j (see Section II.B.2 for instructions on the selection of figures and curves).

4. Using the figure and curve noted in column j, determine whether or not hot spot potential exists; record this determination in column k.

g. Repeat the previous steps in Part IV for each approach.

5. After all approaches have been analyzed, enter the location on the Initial Screening Summary Sheet (see Section II.B.3); include the following data:

a. Location (street names).

b. Type (in this case, signalized intersection).

c. Whether or not a hot spot is indicated - this is affirmative if any entry in columns g or k is affirmative.

e. Step 5 - Repeat Step 4 for all signalized intersections on the street network.

2. Subtask 1-b: Screening Locations Where Conditions of Uninterrupted Flow Prevail

a. Step 1 - Identify sections of expressway where the following conditions prevail:

Highway configuration	ADT
4-lane highway	$\geq$ 30,000
6-lane highway	$\geq$ 40,000
8-lane highway	$\geq$ 50,000

b. Step 2 - For each section identified in Step 1 as meeting the above criteria, enter the highway name or route number in column a of the Preliminary Screening Work Sheet - Uninterrupted Flow (see Section II.B.3). Also on this work sheet, enter the following data for each location:

1. Description of the location (e.g., north of the Brook's Highway Interchange) in column b.
2. The adjusted ADT (winter 1977-78) in column c.
3. Highway configuration (e.g., 4-lane expressway) in column d.
4. Estimated lane capacity in column e.
5. Using the appropriate curve in Figure 10, determine whether or not the facility is a potential hot spot (for instructions on selecting the appropriate curve and use of the figure, see Section II.B.2); record this determination in column f.

c. Step 3 - Upon completion of Step 2, record the locations on the Initial Screening Summary Sheet; include:

1. Facility name and location (from columns a and b of the work sheet).
2. Type of facility (in this case, expressway-uninterrupted flow).
3. Whether or not hot spot potential is indicated (from column f of the work sheet).

d. Step 4 - Identify arterial street sections on the highway network that meet the following criteria:

1. Volumes:

Highway configuration	ADT
2-lane arterial	$\geq$ 10,000
4-lane arterial	$\geq$ 16,000
6-lane arterial	$\geq$ 20,000

2. Proximity to Signalized Intersections: The section should be at least 1 mile from a signalized intersection.

e. Step 5 - For each arterial section identified in Step 4 as meeting the above criteria, enter the street name (or other identifier) in column a of the Preliminary Screening Work Sheet - Uninterrupted Flow (see Section II.B.3). Also on this work sheet, enter the following data for each location:

1. Description of the location (e.g., between Marginal Way and Ober Road) in column b.
2. The adjusted ADT (winter 1977-78) in column c.
3. Street configuration (e.g., 4-lane arterial) in column d.
4. Estimated lane capacity in column e.
5. Using the appropriate curve in Figure 11, determine whether or not the facility is a potential hot spot (for instructions on selecting the appropriate curve and use of the figure, see Section II.B.2); record this determination in column f.

f. Step 6 - Upon completion of Step 5, record the locations on the Initial Screening Summary Sheet; include:

1. Facility name and location (from columns a and b of the work sheet).
2. Type of facility (in this case, arterial-uninterrupted flow).
3. Whether or not hot spot potential is indicated (from column f of the work sheet).

3. Subtask 1-c: Screening of Nonsignalized Intersections

a. Step 1 - Identify all nonsignalized intersections where either the major street or minor street volumes exceed the critical volumes shown below (for various street configurations):

Street configurations		Critical volumes	
Major street	Minor street[a]	Major street	Minor street[a]
2-lanes	2-lanes	10,000	2,500
4-lanes	2-lanes	20,000	2,500
4-lanes	4-lanes	20,000	8,000

[a] Under control of STOP sign.

b. Step 2 - For each intersection identified in Step 1 as meeting the above volume criteria, enter the location in Part I of the Preliminary Screening Work Sheet - Nonsignalized Intersections (see Section II.B.3).

c. Step 3 - For Part II of the work sheet enter the following:

1. For the major through street enter:
    a. Adjusted ADT (winter 1977-78) in column a.
    b. Configuration (e.g., 2-lane arterial) in column b.
    c. Estimated lane capacity in column c.
    d. Using the appropriate curve in Figure 11, determine whether or not hot spot potential exists on the through street (see Section II.B.2 for instructions on selecting the appropriate curve); record this determination in column d.
2. For the first cross-street leg enter:
    a. Street name and its orientation (e.g., Trask Lane, east leg).

b. Adjusted ADT (winter 1977-78) in column e.

c. Configuration (e.g., 2-lane, 2-way) in column f.

d. The figure number and curve to be used for screening in column g (see Section II.B.2 for instructions on the selection of figures and curves).

e. Using the figure and curve designated in column g, determine whether or not hot spot potential exists; record this determination in column h.

3. For the second cross-street leg enter:

a. Street name and its orientation (e.g., Trask Lane, west leg).

b. Adjusted ADT (winter 1977-78) in column i.

c. Configuration (e.g., 2-lane, 1-way) in column j.

d. The figure number and curve to be used for screening in column k (see Section II.B.2 for instructions on the selection of figures and curves).

e. Using the figure and curve designated in column k, determine whether or not hot spot potential exists; record this determination in column l.

d. Step 4 - Upon completion of Step 3, record the locations on the Initial Screening Summary Sheet; include:

1. Location (street names).

2. Type (in this case, nonsignalized intersection).

3. Whether or not a hot spot is indicated - this is affirmative if any entry in columns d, h, or l is affirmative.

4. Other Locations

Other locations may be identified during the initial screening that should be analyzed for possible hot spot potential. These locations may not be obvious solely from analysis of traffic data; however, interviews with local planning or engineering personnel may result in the identification of such locations. These special cases may include access roads to major industrial facilities or office complexes, shopping centers, or public parking areas. Should locations such as this be identified, they should be entered on the Preliminary Screening Summary Sheet.

5. Preliminary Screening Locations Map

The final step in the preliminary screening process is to assign an identification number to each location listed on the Initial Screening Summary Sheet, and then to plot the locations, with their respective identification numbers, on a base map. In preparing this map, separate symbols should be utilized to distinguish signalized intersections, nonsignalized intersections, and locations where uninterrupted flow prevails. Examples of this type of map are illustrated as Figures A-la and A-lb in Appendix A.

D. REFERENCES

1. Guidelines for Air Quality Maintenance Planning and Analysis. Volume 9: Evaluating Indirect Sources. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. Publication Number EPA-450/4-75-001. January 1975.

2. Highway Capacity Manual. Highway Research Board, National Academy of Sciences, National Research Council. Washington, D.C. Special Report No. 87. 1965.

SECTION III

TASK 2 - HOT SPOT VERIFICATION

A. INTRODUCTION

Section II presented a technique for identifying locations on a highway network where a potential exists for traffic-generated carbon monoxide levels to exceed the National Ambient Air Quality Standard (NAAQS) for 8-hour average concentrations. This so-called preliminary screening technique was designed specifically for performing an areawide assessment of an entire city or town using only the most basic data elements and a number of simplifying assumptions. It was stressed that various assumptions used in developing the initial screening technique were intentionally conservative. As a result, many of the locations identified as potential hot spots by the initial screening process may, in fact, not be hot spots after all. In order to verify the hot spot potential of a location further analysis is required utilizing a technique that accounts for physical and operational characteristics particular to that location. The purpose of this section, then, is to present a technique for verifying the hot spot potential at locations where the preliminary screening process indicated that such potential exists.

B. OVERVIEW OF HOT SPOT VERIFICATION

The verification process is a follow-up to the initial screening of an area. The intent is to perform a more precise evaluation of the hot spot potential of a street section or intersection utilizing a technique that permits input of parameters specific to that location rather than assumed parameters. Whereas the initial screening process focused on identification of potential hot spot locations anywhere within a city or town (therefore requiring a very general approach) the verification process involves analysis of specific locations; therefore a more detailed analysis of each location is feasible.

The technique involved is, conceptually, identical to that used for preliminary screening — that is, it is assumed that an explicit relationship exists between air quality and parameters such as traffic operating characteristics, and physical characteristics of an intersection, for particular meteorological conditions. Therefore, if both traffic and physical characteristics are determined and a particular set of meteorological conditions assumed, estimates of the resulting air quality can be made. Again, these estimates are made utilizing a series of nomographs which express a quantitative relationship between various traffic and roadway characteristics, and resulting air quality.

In discussing the verification process it is necessary to first consider the three basic elements incorporated into the procedure — these include the data necessary, the nomographs to be used, and a set of standard forms to be used for performing and recording the verification of potential hot spots.

1. Data Required

Whereas in the preliminary screening process it was emphasized that maximum use should be made of existing general traffic data, the verification process requires current data specific to each site analyzed. This is not to say, however, that use cannot be made of existing data; on the contrary — use of existing data is encouraged if it is determined by responsible traffic engineering or planning personnel to be representative of current traffic conditions and if it is sufficient in detail. The particular data elements are described below.

a. Location Sketch - A sketch should be prepared of each location requiring verification. This sketch should show:

- the approximate geometry of the location
- the number of approach and departure lanes on each leg if the site is an intersection, or just the number of lanes if the site is an expressway or midblock location; a number should be assigned to each lane and recorded on the sketch
- the width of each lane, median, and channelizing island
- the locations within each site where curb parking is permitted and where bus stops and taxi stands are located
- the locations on both sides of each street or roadway where a reasonable receptor is identified
- pertinent notes regarding observations as to the operation of the facility.

Examples of field sketches that include the data required are provided throughout Appendix C.

b. Traffic Volume Data - Peak hour volume data is required for all streets and highways analyzed. Again, these volumes should be representative of the busiest winter month (November through March) projected to 1977-78. This implies that a statistical data base must also be available from which projections are made. The lane distribution of peak hour traffic is also required since computations of carbon monoxide concentrations are performed on a lane by lane basis.

While traffic volume data are often the most abundent data element generally available, it is doubtful that in many instances sufficient data will exist to perform hot spot verification, implying that new data will be required. Again, the appropriateness of existing data should be judged by a competent traffic engineer or planner. In fact, the development of all traffic volume data used in the verification process should be accomplished by a competent engineering/planning professional, this may require direction at the state level. This applies to most of the data development effort required.

c. Vehicle Classification Data - A related element required is the distribution of traffic by vehicle type. This is usually developed for specific highway classifications such as expressways, major arterials, minor arterials, etc. The vehicle classifications that should be identified include:

- light-duty vehicles (passenger cars)
- light-duty trucks (panel and pick-up trucks, light delivery trucks — usually all 2-axle, 4-wheel trucks)
- heavy duty, gasoline-powered vehicles
- diesel-powered vehicles

These data may be available for a community where recent comprehensive transportation planning programs have been accomplished.

d. Traffic Signal Data - A necessary element in the verification of hot spot potential at signalized intersections is the ratio of the green time allocated to each approach, to the total cycle length (G/Cy). This ratio can be determined from records or design plans if the installation is of the fixed-time type but if actuated control is utilized, the ratio must be computed based on the actual peak hour volumes.

Where actuated pedestrian signals are utilized estimates should be made with regard to the number of times during the peak hour that the actuated pedestrian phase is called. Also, where turning lanes are provided but these lanes are subject to interference from stopped through traffic, estimates of this interference should be made. The green time allocated to the approaches affected by these occurrences then must be adjusted. Further explanations of computing G/Cy, including adjusting for interference, are provided in Section IV.A.

e. Lane Capacity - Lane capacity for expressways and midblock locations must be computed from the appropriate data described above. Calculating lane capacity is usually a relatively straightforward procedure; however, in certain instances the computations involve engineering judgments that should be performed by experienced traffic engineering professionals. A valuable source for information regarding the computation of roadway or lane capacity is the 1965 Highway Capacity Manual.[1] Further discussion of capacity is provided in this document in Section IV.E.

f. Vehicle Cruise Speed - Estimates of the cruise speed of vehicles departing from signalized intersections must be made. These can be based on actual field trials or through estimates based on observed operating characteristics and surrounding land use. Further discussion of the procedures involved appear in Section IV.D.

g. Miscellaneous Data - Other data may be required to perform hot spot verification. Included is information relative to planned projects which will directly impact traffic or travel within the study area in the near future. These could involve alterations to the street network, including the addition or deletion of major arterials or expressways, revising circulation patterns, changing signal systems, etc.; or the development of programs which focus on creating mode shifts (e.g., improving bus service for commuters). The expected effect on traffic volumes must be considered where these possibilities exist.

Another area of consideration is with regard to the effects of programs which will have an impact on automotive emissions, such as mandatory inspection and maintenance programs. Where such programs are in effect or are anticipated, their impacts must be estimated. Section IV.B discusses the method for incorporating these impacts into the verification process.

2. Hot Spot Verification Nomographs

Presented here is a series of nomographs to be used for verification of hot spot potential at three general types of locations, including signalized intersections, uninterrupted flow, and nonsignalized intersections. It should be noted that these curves represent concentrations expected from a vehicle mix during the winter of 1977-78.

a. Signalized Intersections - For hot spot verification a lane-by-lane analysis is performed for each leg to estimate the total carbon monoxide contribution from that lane. These lane concentrations are then adjusted for distance from an identified receptor, the sum of which is the estimated receptor concentration.

For signalized intersections, approach lane and departure lane concentrations are computed on separate nomographs. The nomograph used for approach lanes, Figure 23, shows traffic demand per lane in vehicles per hour (abscissa) versus carbon monoxide concentrations in ppm (ordinate). Also, seven curves have been plotted that correspond to various G/Cy (see Section IV.A) for the lane. In using the nomograph, the estimated peak hour lane volume and the G/Cy for the lane are established and from these, a resulting concentration is determined.

For each departure lane, the nomograph presented in Figure 24 is utilized. In this figure it is seen that lane concentrations for any particular hourly volume are a function of the departure cruise speed. Therefore, to use this nomograph to estimate lane concentrations, both peak hour lane volume data and an estimate of the average departure lane cruise speed are required.

Implicitly the nomograph specifies that the concentrations determined are representative of those concentrations estimated to occur 10 meters away from the edge of the traffic lane. In order to determine the concentration at a receptor located at a distance of other than 10 meters, each lane concentration must be adjusted by some factor which accounts for the actual distance between the edge of the lane and the receptor site. These factors can be determined from Figure 25, which depicts relative concentrations as a function of distance from the emissions source (in this case considered to be the near edge of the traffic lane) for both approach and departure lane traffic.

1. Nomographs for Verification at Signalized Intersections - The nomographs to be used for verifying hot spot potential at signalized intersections are presented in Figures 23, 24 and 25, below.

b. Uninterrupted Flow - Two nomographs are presented for estimating lane concentrations where conditions of uninterrupted flow occur. The first of these, Figure 26, expresses lane concentration as a function of the volume to capacity ratio (V/C) and the lane capacity for freeways or expressways. Again, the concentrations are assumed to occur a distance of 10 meters from the edge of the lane.

A corresponding nomograph for arterial streets is presented in Figure 27. Again, lane concentrations are shown to be a function of V/C and lane capacity.

Correction factors for varying lane edge to receptor distances are shown in Figure 28.

1. Nomographs for Verification of Locations Where Uninterrupted Flow Prevails - The nomographs to be used for verification of hot spot potential on expressways and midblock locations of arterial streets are shown in Figures 26, 27 and 28, below.

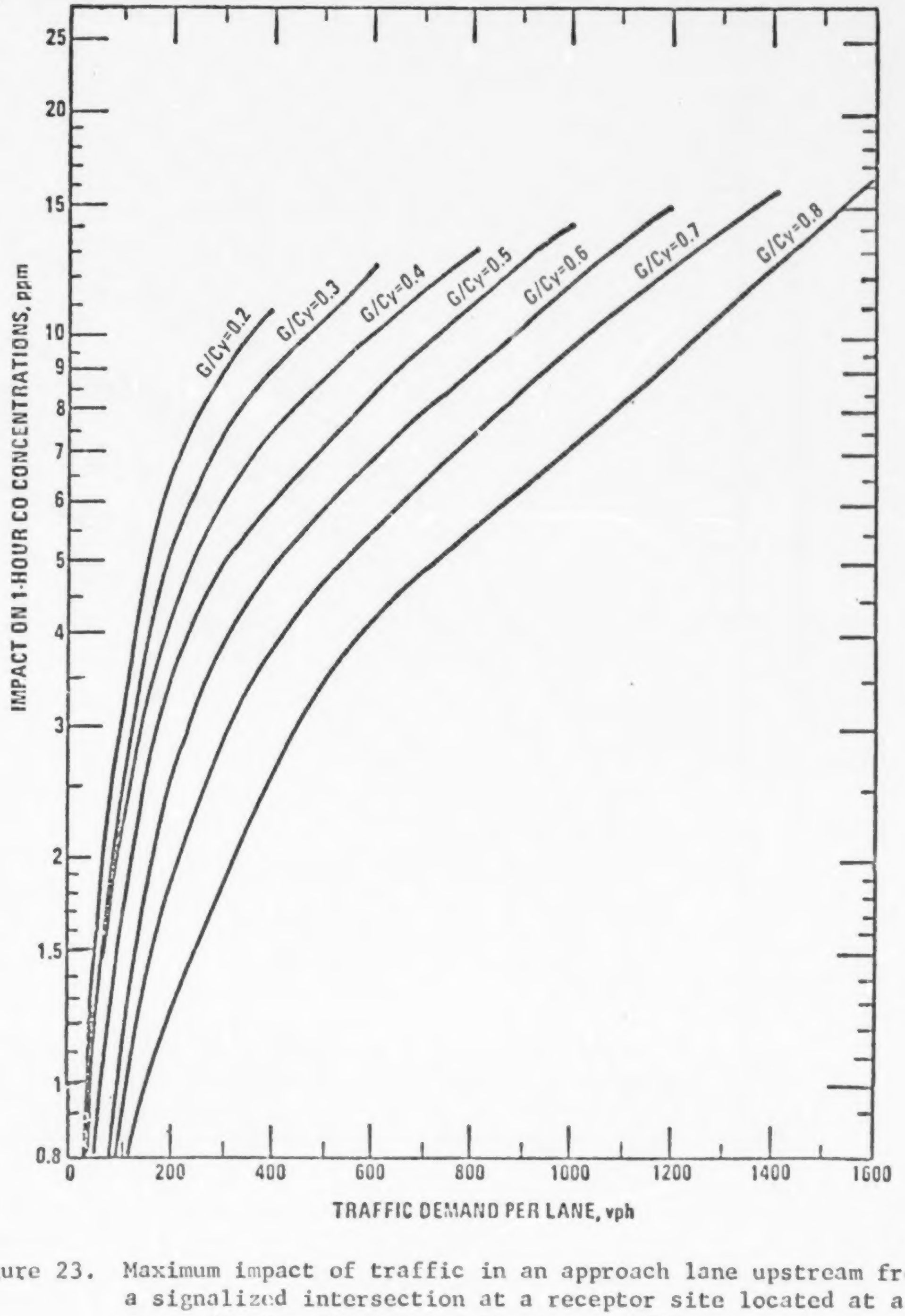


Figure 23. Maximum impact of traffic in an approach lane upstream from a signalized intersection at a receptor site located at a perpendicular distance of 10 meters, 1977

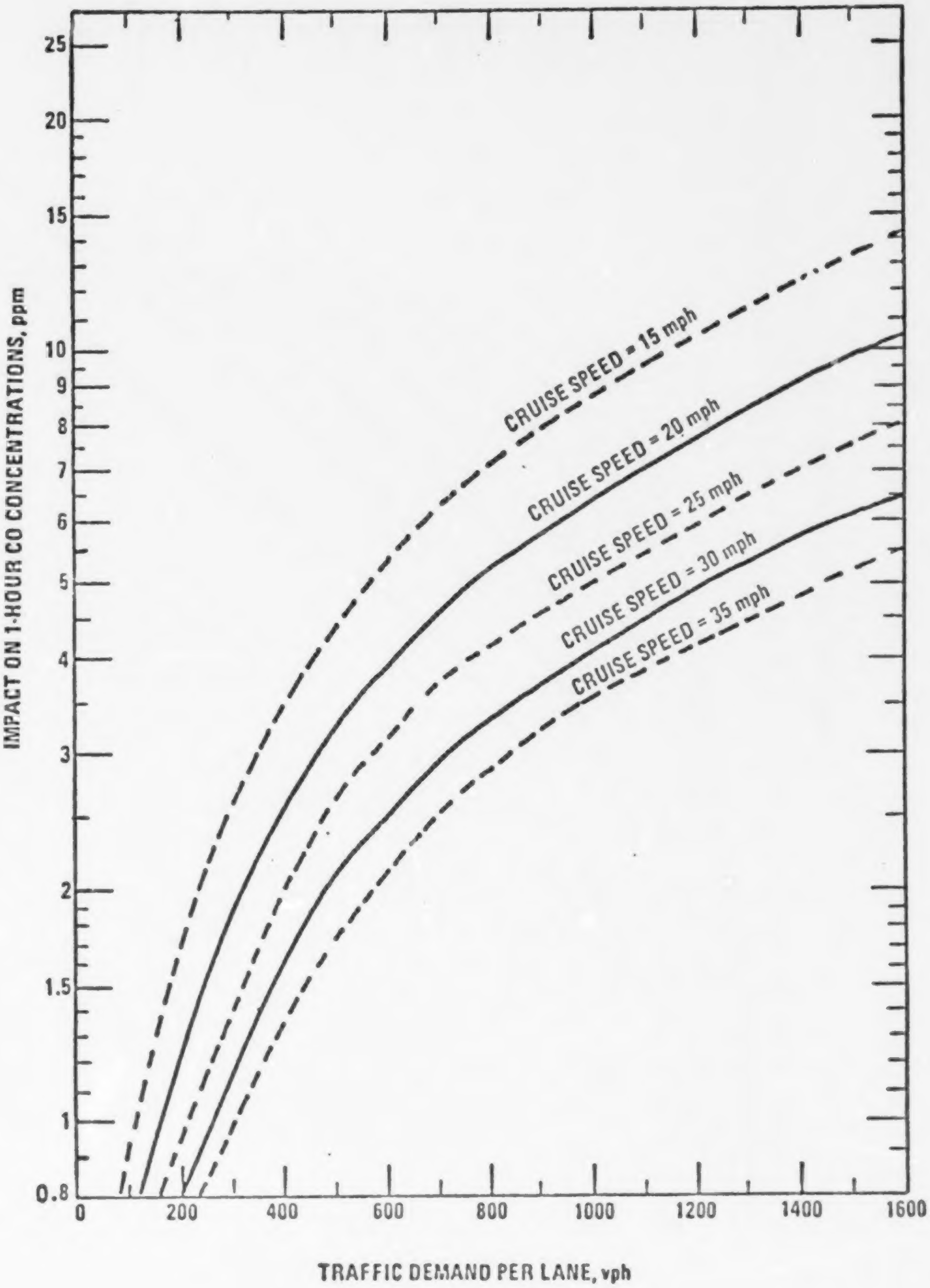


Figure 24. Maximum impact of traffic in a lane downstream from an intersection at a receptor site located a perpendicular distance of 10 meters away, 1977

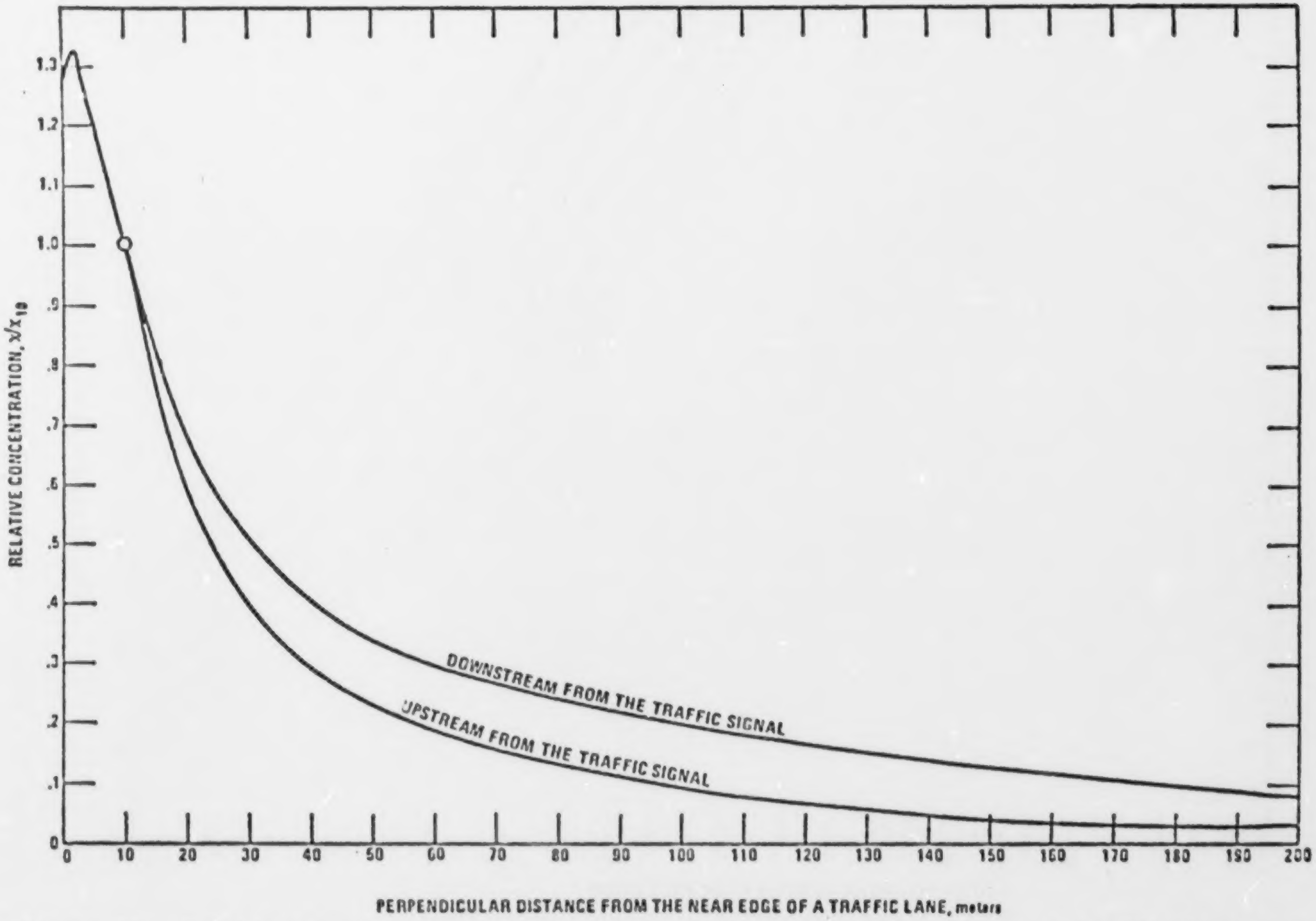


Figure 25. Relative concentration of CO versus perpendicular distance from a traffic lane near a signalized intersection

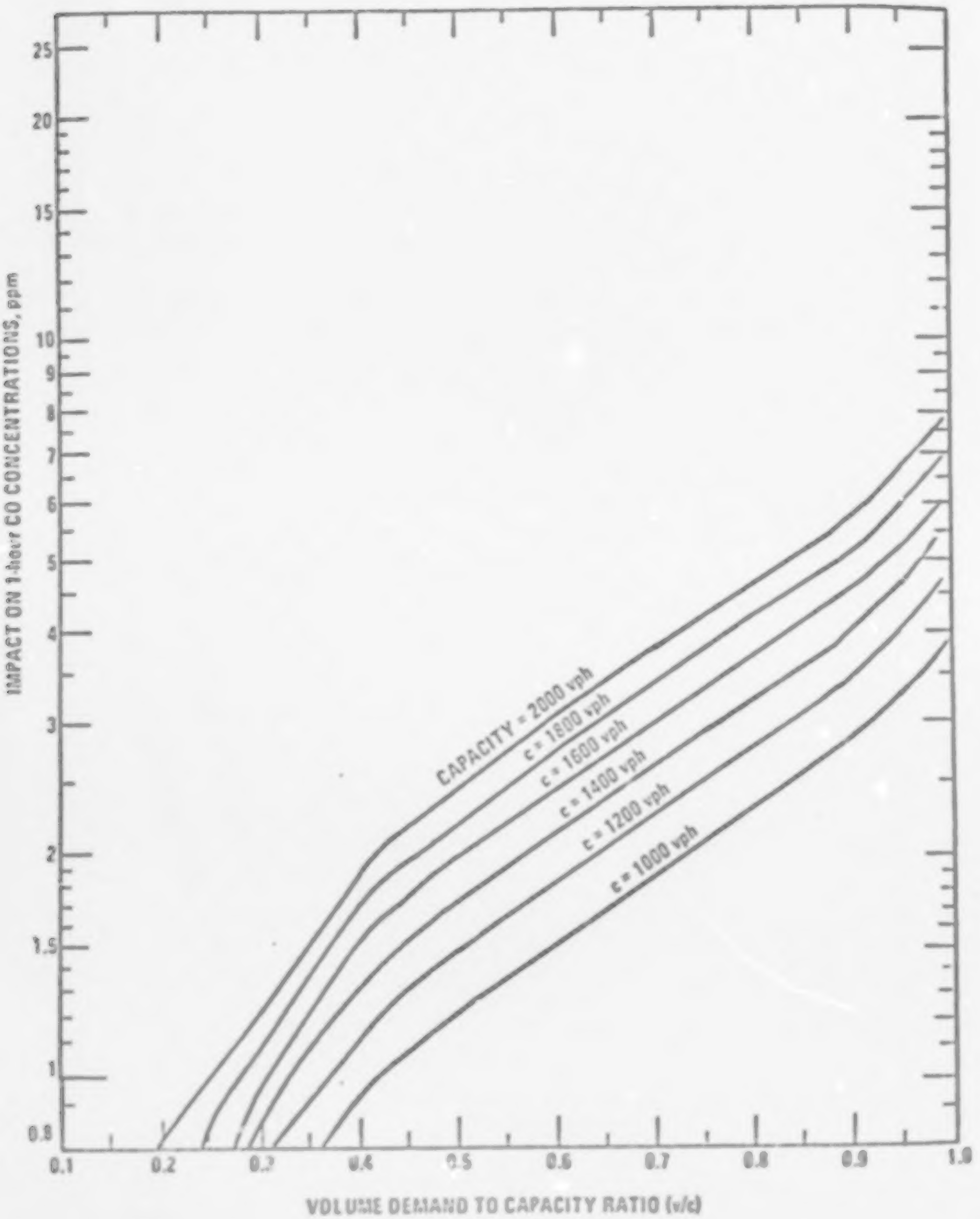


Figure 26. Volume demand - capacity ratio in a freeway or expressway lane versus CO concentration impact at a perpendicular distance of 10 meters, 1977

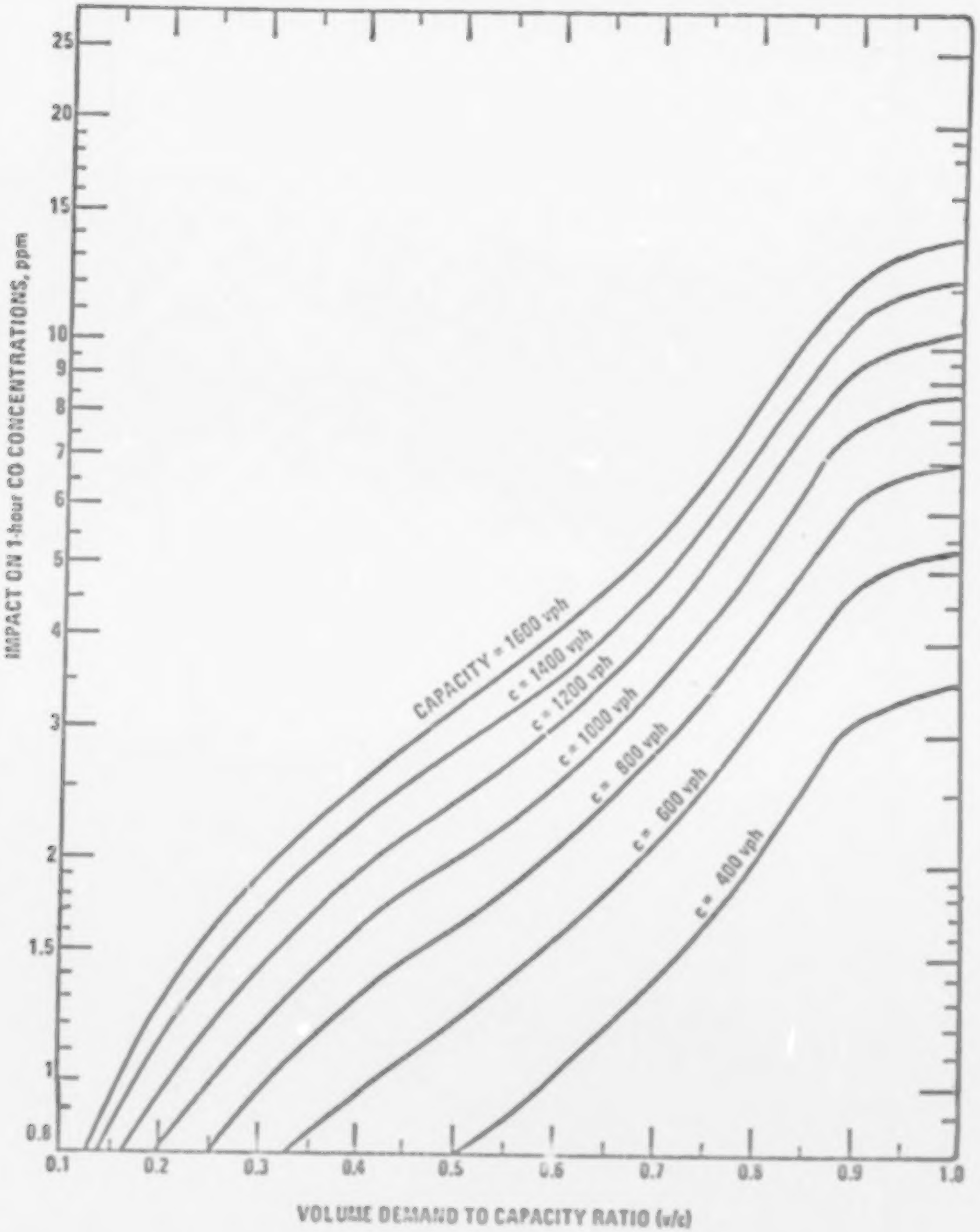


Figure 27. Volume demand - capacity ratio in a lane on a major street versus CO concentration impact at a perpendicular distance of 10 meters, 1977

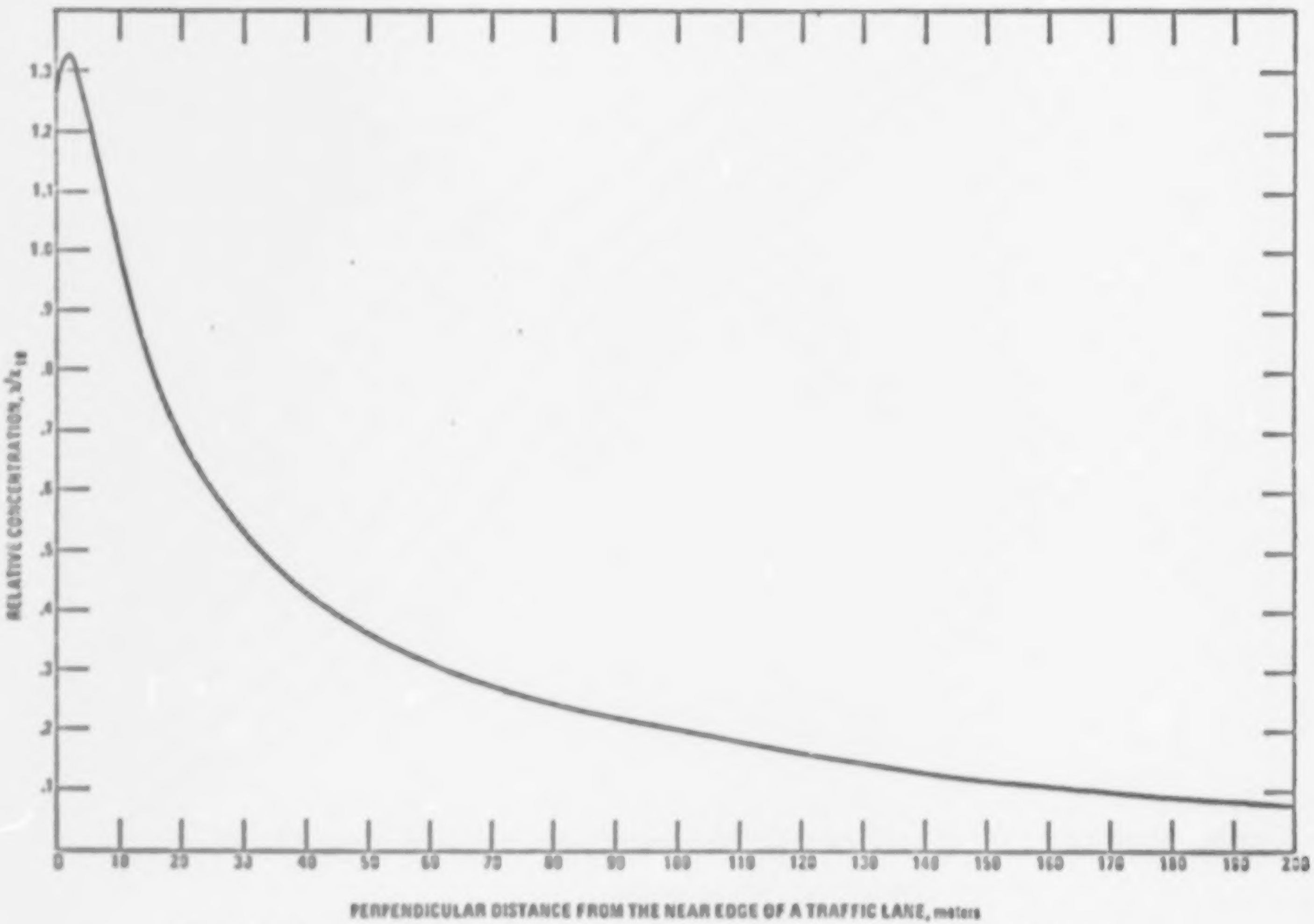


Figure 28. Relative concentration of CO versus perpendicular distance from a traffic lane with freely flowing traffic

c. Nonsignalized Intersections - Carbon monoxide concentrations at STOP-sign controlled intersection legs are estimated from the nomograph presented in Figure 29, for the approach lanes, and Figure 24 for departure lanes. It is seen from Figure 29 that concentrations are a function of the V/C and lane capacity. However, it is also shown that once the V/C reaches a certain point queuing occurs on the approach and concentrations increase sharply. For example, if the V/C is 0.6 and the lane capacity is about 500 vehicles per hour, the resulting lane concentration is about 3.4 ppm. If conditions were such that queuing did not occur, the same V/C and capacity would result in a lane concentration of about 2.5 ppm. Lane edge to receptor distance correction factors are shown in Figure 30. These factors are applied directly to the lane concentrations computed from Figures 24 and 29.

1. Nomographs for Verification at Nonsignalized Intersections - The nomographs for determining approach lane concentrations and correction factors are presented in Figures 29 and 30, below, while the nomograph for estimating departure lane concentrations is presented in Figure 24.

3. Hot Spot Verification Forms

Presented below are standard forms to be used as work sheets and summary sheets for verifying hot spot potential. These forms should also be used for reporting hot spot verification. Included are the following:

• Hot Spot Verification Summary	Form 5
• Hot Spot Verification Work Sheet - Field Data	Form 6
• Hot Spot Verification Work Sheet - Signalized Intersections	Forms 7a, 7b, 7c
• Hot Spot Verification Work Sheet - Uninterrupted Flow	Form 8
• Hot Spot Verification Work Sheet - Nonsignalized Intersections	Forms 9a, 9b

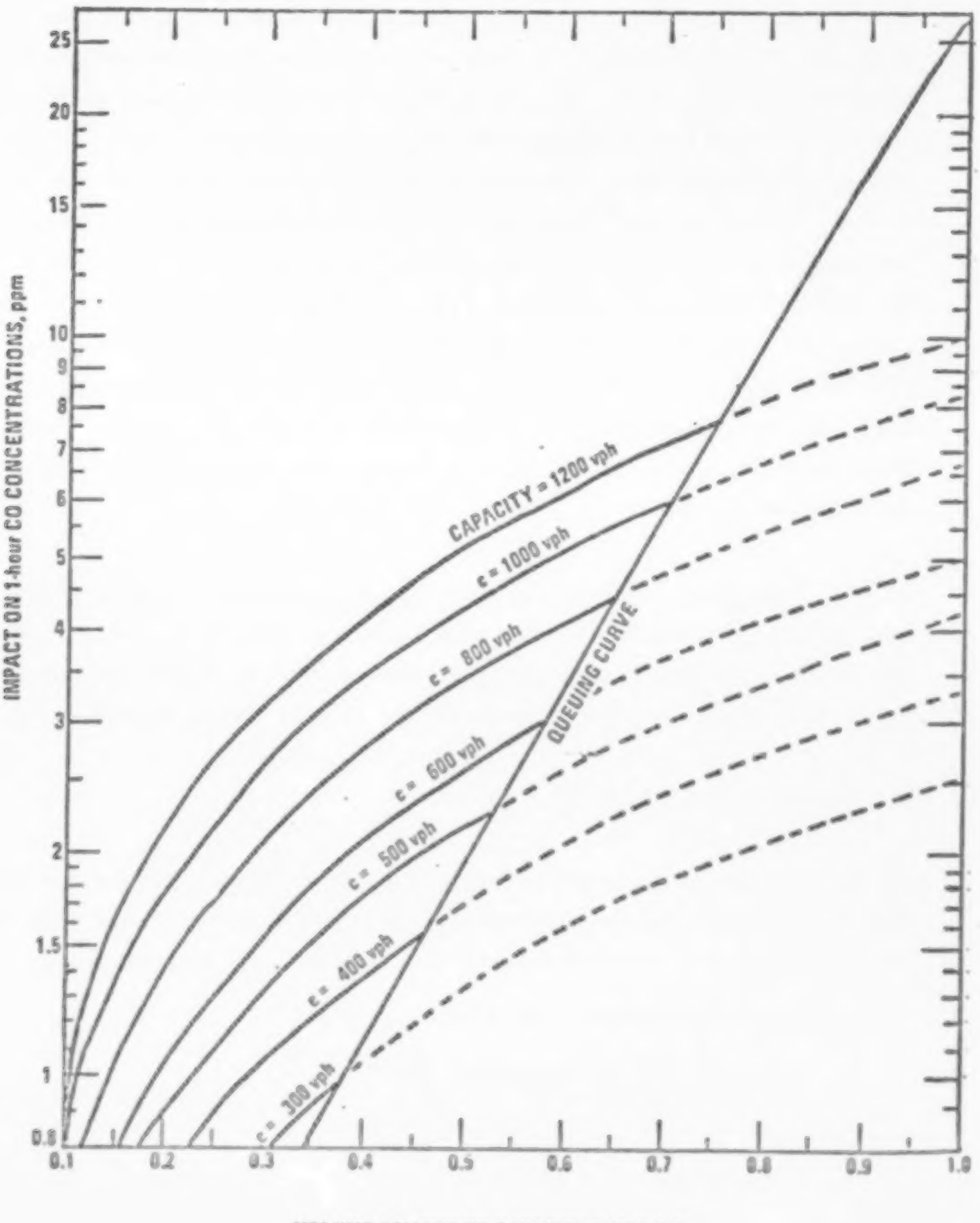


Figure 29. Impact of traffic upstream from a nonsignalized intersection on CO concentrations at a receptor site located a perpendicular distance of 10 meters away, 1977

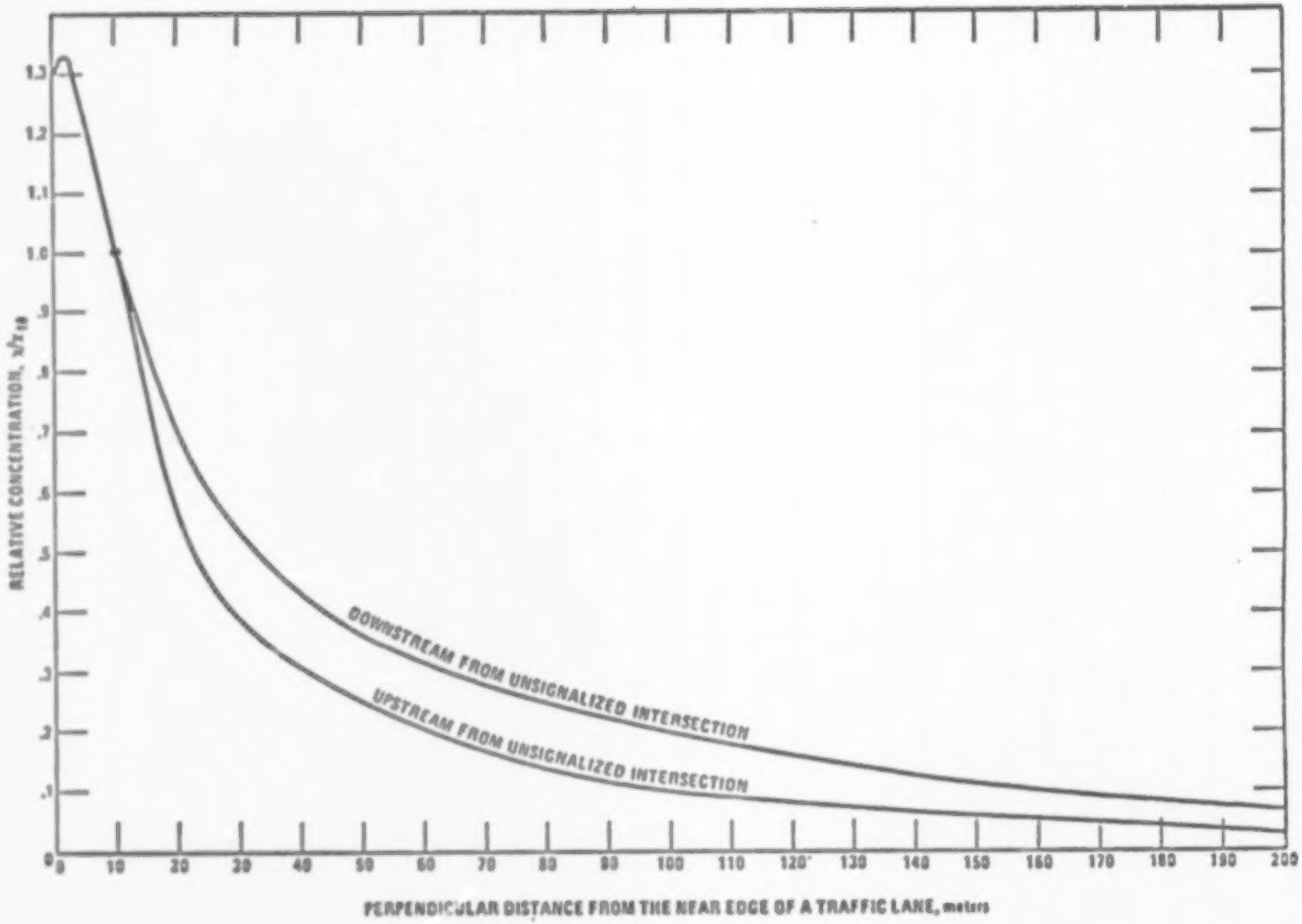


Figure 30. Relative concentration of CO versus perpendicular distance from a traffic lane near a nonsignalized intersection

A brief description of each of these forms is presented below.

a. Hot Spot Verification Summary (Form 5) - This form is intended to be used for summarizing the hot spot verification effort. To complete the form the location number (corresponding to the number assigned to the location during preliminary screening), location name, and the maximum concentration computed, are entered. It is noted that for all intersections and many expressways and midblock arterials analyzed, more than one concentration will be computed. It is emphasized that only the maximum of all those concentrations computed for any one location should be entered on the Summary Sheet.

b. Hot Spot Verification Work Sheet — Field Data (Form 6) — This form provides space for a sketch of the facility or site being evaluated. Included in the sketch should be those elements mentioned in the previous text (Section III.B.1.a) regarding the geometry, layout, and physical dimensions of the site. Also, notes regarding traffic operations, receptor type, terrain features, land-use characteristics, etc., should be included. The orientation of the site should be indicated using a north arrow. If various abbreviations are used in preparing the site sketches, these should be consistent throughout; also, these should be defined in at least one location. Examples of completed Field Data Forms are provided throughout Appendix C.

c. Hot Spot Verification Work Sheet — Signalized Intersection (Forms 7a, 7b, 7c) — This is a three-page form used to verify the hot spot potential of one signalized intersection. As can be seen, this form is composed of several parts; each of these is described briefly below.

Part I provides space for recording the peak hour volumes for each lane on each intersection leg. In the first column under the heading "Intersection Leg," the street name and its orientation should be entered. The

HOT SPOT VERIFICATION SUMMARY

City/Town: ______________________ State: ____________ page ___of ___

Analysis By: ______________________ ______________________ Date: ________
(name) (title)

Approved By: ______________________ ______________________ Date: ________
(name) (title)

Location No.	Location	Maximum 8-hr. Ave. Concentration

Form 5

HOT SPOT VERIFICATION WORK SHEET – FIELD DATA

City/Town: ______________________ By: __________

Location: ______________________ Date: __________

Sketch of location and notes:

Form 6

HOT SPOT VERIFICATION WORK SHEET – SIGNALIZED INTERSECTION

page 1 of ___

City/Town/: ____________________ By: ________________

Intersection: ____________________ Date: ________________

I. PEAK HOUR VOLUMES: Enter Lane Numbers (from sketch) and peak hour volumes for winter 1977-78 (from data sheets).

Intersection Leg	Peak Hour Volumes							
	Approach Lane No.				Departure Lane No.			

II. AVERAGE G/Cy AND CRUISE SPEED: Enter average G/Cy for approach lanes (from data sheets) and average cruise speed for departure lanes.

Intersection Leg	Average G/C_y				Average Cruise Speed			
	Approach Lane No.				Departure Lane No.			

III. RESULTING LANE CONCENTRATIONS: Enter lane concentrations for approach lanes (obtained from Figure No. 23), and departure lane concentrations (obtained from Figure No. 24).

Intersection Leg	Computed Lane Concentrations							
	Approach Lane No.				Departure Lane No.			

Form 7a

HOT SPOT VERIFICATION WORK SHEET – SIGNALIZED INTERSECTIONS (continued)

page 2 of ___

Intersection: ______________ City/Town/: ______________

IV-A. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factor for each lane (obtained from Figure No. 25) assuming receptor is on the approach side of each leg.

Intersection Leg	Distance Correction Factors							
	Approach Lane No.				Departure Lane No.			

IV-B. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factor for each lane (obtained from Figure No. 25) assuming receptor is on the departure side of each leg.

Intersection Leg	Distance Correction Factor							
	Approach Lane No.				Departure Lane No.			

V-A. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter the concentration from each lane corrected for lane edge to receptor distance; this is computed as the product of lane concentrations (from III, above) and the corresponding lane edge to receptor distance correction factor (from IV A, above); assuming receptor is on the approach side of each leg.

Intersection Leg	Corrected Lane Concentrations								Total
	Approach Lane No.				Departure Lane No.				

Form 7b

HOT SPOT VERIFICATION WORK SHEET – SIGNALIZED INTERSECTIONS (Continued)

page 3 of __

Intersection: ________________ City/Town/: ________________

V-B. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter the concentration from each lane corrected for lane edge to receptor distance; this is computed as the product of lane concentrations (from III, above) and the corresponding lane edge to receptor distance correction factor (from IV-B, above); assuming receptor is on the departure side of each leg.

Intersection Leg	Corrected Lane Concentrations								Total
	Approach Lane No.				Departure Lane No.				

VI-A. FINAL COMPUTATIONS FOR MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following data: (1) receptor concentration (from V-A, above) in column a; (2) f_{vm} (from data sheet) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; and (4) 8-hr correlation factor (0.7 unless determined otherwise) in column f. Compute concentrations as shown in columns c, e, and g. Assume receptor is on the approach side of each leg.

Intersection Leg	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)

VI-B. FINAL COMPUTATIONS FOR MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following data; (1) receptor concentration (from V-B, above) in column a; (2) f_{vm} (from data sheet) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; and (4) 8-hr correlation factor (0.7 unless determined otherwise) in column f. Compute concentrations as shown in columns c, e, and g. Assume receptor is on the departure side of each leg.

Intersection Leg	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)

Form 7c

HOT SPOT VERIFICATION WORK SHEET – UNINTERRUPTED FLOW

page___of ___

City/Town: ____ By: __________

Street/Highway Section: ______________________________ Date: ________

I. BASIC COMPUTATIONS:

Item	________ bound Lane No.				________ bound Lane No.			
A. VOLUMES: Enter peak hour volumes for winter 1977-78 (from data sheets)								
B. LANE CAPACITY: Enter lane capacity (from data sheets)								
C. V/C: Enter V/C for each lane (A ÷ B, above)								
D. LANE CONCENTRATIONS: Enter lane concentrations computed from A and C, above, and Figure 26 or 27								

II. CORRECT FOR LANE EDGE TO RECEPTOR DISTANCES:

Assume receptor is on ________________ side of street

Item	________ bound Lane No.				________ bound Lane No.				TOTAL
A. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig. 28)									☒
B. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-D and II-A, above									

Assume receptor is on ________________ side of street

Item	________ bound Lane No.				________ bound Lane No.				TOTAL
C. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig. 28)									☒
D. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-D and II-C, above									

III. FINAL COMPUTATIONS OF MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS

Item	Receptor Location (street-side)	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlac. Factor	g Est. 8-hr Ave. Conc. (e x f)
A. FINAL COMPUTATIONS OF 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following: (1) total receptor concentrations (from II-B and II-D, above) in column a; (2) f_{vm} (from data sheets) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; (4) 8-hr correlation factor (0.7 unless otherwise determined) in column f. Compute final concentrations as shown in columns c, e, and g, for receptors on both sides of street								

Form 3

HOT SPOT VERIFICATION WORK SHEET – NONSIGNALIZED INTERSECTIONS

page 1 of ___

City/Town: ______________________________ By: __________

Intersection: ______________________________ Date: __________

Type of Control: ___all-way STOP; ___1 or 2-way STOP; ___YIELD; ___None;

Street Controlled: ______________________________________

I. BASIC COMPUTATIONS:

Item	Leg: ____________				Leg: ____________			
	Approach Lane No.		Departure Lane No.		Approach Lane No.		Departure Lane No.	
A. VOLUMES: Enter peak hour volumes for winter 1977-78 (from data sheets)								
B. LANE CAPACITY: Enter lane capacity of approach lanes (from data sheets)			☒	☒			☒	☒
C. V/C: Enter V/C for approach lanes (computed as as A ÷ B, above)			☒	☒			☒	☒
D. CRUISE SPEED: Enter departure lane cruise speed (from data sheets)	☒	☒			☒	☒		
E. LANE CONCENTRATIONS: Enter lane concentrations computed from A, C, and D, above, and Fig.29 & 24								

II. CORRECT FOR LANE EDGE TO RECEPTOR DISTANCES:

Assume receptor is on ____________________ side of street

Item	Leg: ____________				TOTAL	Leg: ____________				TOTAL
	Approach Lane No.		Departure Lane No.			Approach Lane No.		Departure Lane No.		
A. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig. 30)					☒					☒
B. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-E and II-A, above										

Assume receptor is on ____________________ side of street

Item	Leg: ____________				TOTAL	Leg: ____________				TOTAL
	Approach Lane No.		Departure Lane No.			Approach Lane No.		Departure Lane No.		
C. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig. 30)					☒					☒
D. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-E and II-C, above										

Form 9a

HOT SPOT VERIFICATION WORK SHEET – NONSIGNALIZED INTERSECTION (continued)

page 2 of ___

City/Town: ____________________

Intersection: ____________________

Street Controlled: ____________________

III. FINAL COMPUTATIONS OF MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATION

Intersection Leg: ____________________

Item	Receptor Location (street-side)	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
A. FINAL COMPUTATIONS OF 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following; (1) total receptor concentrations (from II-B and II-D, above) in column a; (2) f_{vm} (from data sheets) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; (4) 8-hr correlation factor (0.7 unless otherwise determined) in column f. Compute final concentrations as shown in columns c, e, and g, for receptors on both sides of street								

Intersection Leg: ____________________

Item	Receptor Location (street-side)	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
A. FINAL COMPUTATIONS OF 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following; (1) total receptor concentrations (from II-B and II-D, above) in column a; (2) f_{vm} (from data sheets) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; (4) 8-hr correlation factor (0.7 unless otherwise determined) in column f. Compute final concentrations as shown in columns c, e, and g, for receptors on both sides of street								

Form 9b

assigned lane numbers (see Section III.B.1.a., the second item in the listing) should be recorded under the subheadings "Approach Lane No." and "Departure Lane No."; the entries mentioned to this point should be repeated in Parts II through V-B. To complete Part I, the peak hour volumes representing 1977-78 traffic should be entered for each lane.

In Part II, the G/Cy and the estimated departure cruise speed for each approach and departure lane, respectively, are entered. Instructions for estimating G/Cy and cruise speed are provided in Sections IV.A and IV.D, respectively.

From the data contained in Parts I and II, lane concentrations are computed using Figures 23 and 24. These are entered in Part III.

Part IV is divided into IV-A and IV-B. In both Parts IV-A and IV-B, the lane edge to receptor distance correction factor, obtained from data provided in the site sketch and Figure 25, is entered. In IV-A, the factor is based on a receptor located on the approach side of the street, while the factor to be entered in IV-B assumes that the receptor is located on the departure side of the street.

The lane concentrations entered in Part III are multiplied by the lane edge to receptor distance correction factors entered in Part IV-A, and the product entered in Part V-A. The lane concentrations in Part III are then multiplied by the lane edge to receptor correction factors appearing in Part IV-B, and the results entered in Part V-B. The corrected lane concentrations are then summed for each intersection leg.

In Parts VI-A and VI-B the final total concentrations are computed for receptors on the approach and departure sides of each leg, respectively. In these computations a local emissions correction factor, f_{vm} (see Section IV-B), is applied to the concentrations in Parts V-A and V-B, and a background concentration is added to this, yielding a total 1-hour average concentration. An 8-hour correlation factor (see Section IV.F) is then applied to yield an estimated maximum 8-hour average concentration. Sample completed forms appear in Appendix C.

d. Hot Spot Verification Work Sheet – Uninterrupted Flow (Form 8) – This is a three-part form used to verify hot spot potential on expressways, midblock sections of arterial streets, or other locations where conditions of uninterrupted flow prevails. In Part I, the peak hour volumes and capacity for each lane of the roadway are entered on lines A and B, and the ratio of the volume to the capacity for each lane is entered on line C. Using the V/C and volume for each lane, individual lane concentrations are computed using the nomograph provided in either Figure 26 for expressways, or Figure 27 for arterial streets.

In Part II, lines A and B, the lane edge to receptor distance correction factor and the corrected lane concentrations are entered. It should be indicated which side of the facility the receptor is located on. The lane edge to receptor distance correction factor is obtained from Figure 28. The same types of data are entered on lines C and D but assuming the receptor is located on the opposite side of the roadway.

In Part III, the final computations are performed by adjusting the concentrations determined in Part II-B and II-D, for local emissions and background concentrations, and then to obtain the 8-hour average. The top line is used for the concentration computed in Part II-B, while the bottom line is for the concentration in Part II-D. Sample completed forms appear in Appendix C.

e. Hot Spot Verification Work Sheet – Nonsignalized Intersections (Forms 9a and 9b) – This is a two-page form used for verifying hot spot potential on the controlled leg(s) of a nonsignalized intersection. Two legs can be evaluated on each form.

In Part I, the peak hour volume and capacity of each lane of the controlled intersection leg are entered on lines A and B, respectively. The ratio of the volume to capacity, V/C, for each lane is then entered on line C and resulting lane concentrations are computed from the lane volume and V/C, using the nomograph provided in Figure 29.

In Part II-A and II-B, the lane edge to receptor distance correction factor (obtained from the nomograph presented in Figure 30) and corrected lane concentrations are entered. The same data is entered in II-C and II-D for a receptor located on the opposite side of the street. In each case, it should be indicated which side of the street the receptor is assumed to be located on.

In Part III-A, final computations are made, adjusting the concentrations computed in Part II for local emissions and background, and further adjusting the concentration to represent the 8-hour average. The two lines are provided in order to compute concentrations at receptors located on both sides of the intersection leg. Part III-B is provided for computing concentrations on the second leg (if any) of the intersection. The intersection leg being analyzed should be entered on the line provided. Sample completed forms are provided in Appendix C.

4. Performing Hot Spot Verification

Before discussing the detailed instructions for hot spot verification, it may be helpful to see generally how the various data, nomographs, and forms are utilized. This is best illustrated by the flow diagram provided in Figure 31.

The flow diagram illustrates that as a result of the preliminary screening process, locations analyzed can be classified as not having hot spot potential, having hot spot potential, or as being either a complex intersection or special case (in either instance, nothing is implied regarding hot spot

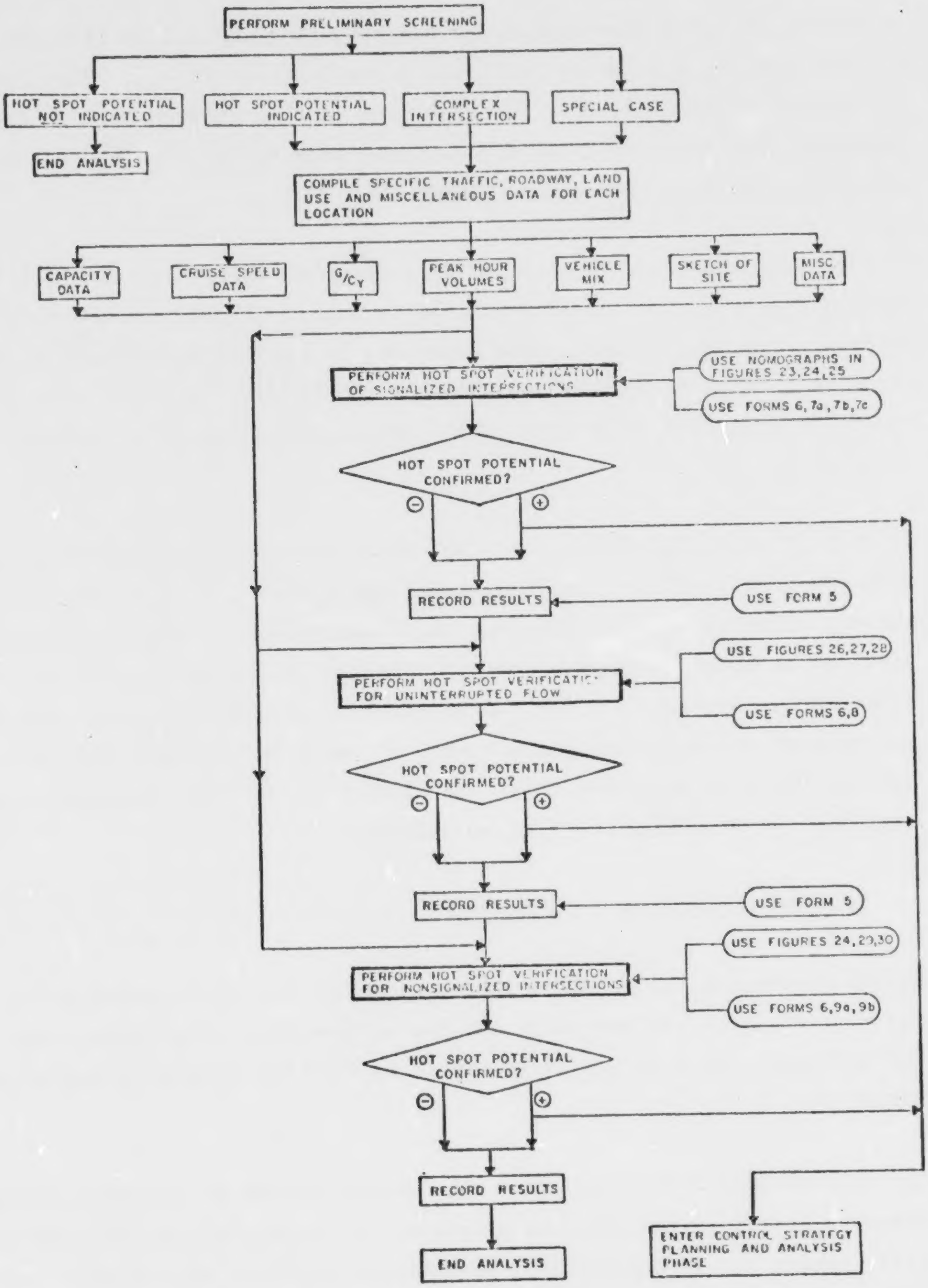

PERFORM PRELIMINARY SCREENING
HOT SPOT POTENTIAL NOT INDICATED
HOT SPOT POTENTIAL INDICATED
COMPLEX INTERSECTION
SPECIAL CASE
END ANALYSIS
COMPILE SPECIFIC TRAFFIC, ROADWAY, LAND USE AND MISCELLANEOUS DATA FOR EACH LOCATION
CAPACITY DATA
CRUISE SPEED DATA
G/CY
PEAK HOUR VOLUMES
VEHICLE MIX
SKETCH OF SITE
MISC DATA
PERFORM HOT SPOT VERIFICATION OF SIGNALIZED INTERSECTIONS
USE NOMOGRAPHS IN FIGURES 23,24,25
USE FORMS 6, 7a, 7b, 7c
HOT SPOT POTENTIAL CONFIRMED?
⊖
⊕
RECORD RESULTS
USE FORM 5
PERFORM HOT SPOT VERIFICATION FOR UNINTERRUPTED FLOW
USE FIGURES 26,27,28
USE FORMS 6,8
HOT SPOT POTENTIAL CONFIRMED?
⊖
⊕
RECORD RESULTS
USE FORM 5
PERFORM HOT SPOT VERIFICATION FOR NONSIGNALIZED INTERSECTIONS
USE FIGURES 24,29,30
USE FORMS 6,9a,9b
HOT SPOT POTENTIAL CONFIRMED?
⊖
⊕
RECORD RESULTS
END ANALYSIS
ENTER CONTROL STRATEGY PLANNING AND ANALYSIS PHASE

Figure 31. Process flow diagram for the hot spot verification procedure

potential). The diagram further illustrates that only locations classified as having hot spot potential or as being complex or special cases, are considered in the verification process.

The remainder of the diagram shows the order in which analyses are performed and which nomographs and forms are used for each portion of the analysis. It is also shown that for locations where hot spot potential is confirmed, further analyses are required involving the development of control measures and more sophisticated air quality analyses. This advanced phase of the overall process for assessing carbon monoxide problems is beyond the immediate scope of this document.

C. DETAILED INSTRUCTIONS FOR PERFORMING HOT SPOT VERIFICATION

As mentioned previously, the hot spot verification process permits data specific to a particular location to be utilized to determine the likelihood of carbon monoxide hot spots occurring. This technique also provides a quantitative analysis that can be utilized to compare relative hot spot potential throughout a highway network. For this reason the verification procedure can be very useful not only for identifying hot spots, but also as an aid in the planning process for resolving hot spot problems.

The general procedure involves obtaining data specific to each location and relating these data to air quality, again through the use of a series of nomographs (see Section III.B.1). The data requirements for each location type (e.g., signalized intersections, nonsignalized intersections, free flowing street/highway sections) vary somewhat as will be indicated by the instructions which follow.

1. Subtask 2-a: Hot Spot Verification at Signalized Intersections

a. Step 1 - Prepare a sketch of each intersection on a Hot Spot Verification Work Sheet - Field Data (see Section III.B.3); include the following data:

1. Approximate geometry of the intersection.
2. The number of approach and departure lanes on each leg; also, assign a number to each lane on each leg.
3. The width of each lane, median, and channelizing island.
4. The locations within the intersection where curb parking is permitted and where bus stops or taxi stands exist.
5. The location on each leg where a reasonable receptor (see Section IV.C) is identified; these should be identified on the sketch as receptors, and the distance from these to the nearest edge of each street lane must be provided.

6. Pertinent notes regarding observations as to operation of the intersection, interference to traffic flow by pedestrians or other frictions, surrounding land use, estimated departure speeds, etc.

7. All street names and a north arrow.

b. Step 2 - The following pertains to the Hot Spot Verification Work Sheet - Signalized Intersections (see Section III.B.3). These should be completed for each intersection as follows:

1. Enter the data indicated in the heading.

2. Part I:

   a. For each leg enter the street name and its orientation (e.g., Newton Road, east leg) in the first column.

   b. Enter the lane number (see item 2 in Step 1, above) for each approach and departure lane, as indicated.

   c. Enter the adjusted peak hour volume (winter 1977-78) for each approach and departure lane.

3. Part II:

   a. For each leg enter the street name and its orientation, and the lane numbers.

   b. Enter the average G/Cy (see Section IV.A.) for each approach lane, and the estimated average cruise speed (see Section IV.D.) for each departure lane.

4. Part III:

   a. For each leg enter the street name and its orientation, and the lane numbers.

   b. Using the approach lane volumes and corresponding G/Cy (from Parts I and II, respectively) and Figure 23, compute the approach lane concentrations; record these in Part III.

   c. Using the departure lane volumes and corresponding departure cruise speed (from Parts I and II, respectively) and Figure 24, compute the departure lane concentrations; record these in Part III.

5. Part IV-A (Assume that the receptor is on the approach side of each leg):

   a. Enter street name and orientation, and lane numbers for each leg.

   b. Enter the lane edge to receptor correction factor determined from Figure 25 for the approach and departure lanes on each leg.

6. Part IV-B (Assume that the receptor is located on the departure side of each leg):

   a. Repeat the procedure outlined in 5., above, only assuming that the receptor is located on the opposite side of the street.

7. Part V-A (Assume that the receptor is located on the approach side of each leg):

   a. Enter the street name and orientation, and lane numbers for each leg.

   b. Compute the corrected lane concentrations as the product of the lane concentrations presented in Part III, and the lane edge to receptor distance correction factors presented in Part IV-A; record these and the total concentration for each leg.

8. Part V-B (Assume that the receptor is located on the departure side of each leg):

   a. Enter the street name and orientation, and lane numbers for each leg.

   b. Compute the corrected lane concentrations as the product of the lane concentrations presented in Part III, and the lane edge to receptor distance correction factors presented in Part IV-B; record these and the total concentration for each leg.

9. Part VI-A (Assume receptor is located on the approach side of each leg):

   a. Enter the street name and orientation, and the lane numbers for each leg.

   b. Enter the total concentration for each leg from Part V-A, in column a.

   c. Enter the vehicle mix correction factor, f_{vm}, computed for each leg in accordance with instructions provided in Section IV-B, in column b.

   d. Enter the product of the total concentration and vehicle mix correction factor (a x b) in column c.

   e. Enter the estimated maximum 1-hour average background concentration (see Section IV.G) in column d.

   f. Enter the sum of columns c and d in column e.

   g. Enter the 8-hour correlation factor (see Section IV.F) in column f.

   h. Enter the total maximum 8-hour average concentration expected at the receptor, computed as the product of columns e and f, in column g.

10. Part VI-B (Assume receptor is located on the departure side of each leg):

   a. Enter the street name and orientation, and the lane numbers for each leg.

   b. Enter the total concentration for each leg from Part V-B, in column a.

   c. Enter the vehicle mix correction factor, f_{vm}, (same as f_{vm} entered in column b in Part VI-A) in column b.

   d. Enter the product of the total concentration and vehicle mix correction factor (a x b) in column c.

   e. Enter the estimated maximum 1-hour average background concentration (same as d in Part VI-A) in column d.

   f. Enter the sum of columns c and d in column e.

   g. Enter the 8-hour correlation factor (same as f in VI-A) in column f.

   h. Enter the total maximum 8-hour average concentration expected at the receptor, computed as the product of columns e and f, in column g.

c. Step 3 - Upon completion of step 2, above, the following data are entered for each location on the Hot Spot Verification Summary Sheet (Form 5):

    1. The location and its assigned number (see Section III.B.3.a).
    2. The highest of the two concentrations computed for each leg in column g of Parts VI-A and VI-B of the Hot Spot Verification Work Sheets.

2. Subtask 2-b: Hot Spot Verification at Locations Where Conditions of Uninterrupted Flow Prevail

a. Step 1 - Prepare a sketch of each location to be analyzed on a Hot Spot Verification Work Sheet - Field Data (see Section III.B.3.b.); include the same data as was indicated in Step 1 for Hot Spot Verification at Signalized Intersections (see Section III.C.1.a.).

b. Step 2 - The following pertains to the Hot Spot Verification Work Sheet - Uninterrupted Flow (see Section III.B.3.d.). These sheets should be completed for each location, as follows:

1. Enter the appropriate data in the heading of the sheet.
2. Part I:
    a. Enter the lane numbers and direction of flow.
    b. Enter the adjusted peak hour volume (winter 1977-78) on line A for each lane.
    c. Enter the lane capacity (vehicles per hour) on line B.
    d. Enter the lane volume to capacity ratio, computed as line A divided by line B, on line C.
    e. Enter the resulting lane concentration on line D, computed from either Figure 26 (if the facility is an expressway) or Figure 27 (if the facility is an arterial), and the volume to capacity ratio (from line C) and the capacity (from line B).
3. Part II:
    a. Designate the side of the roadway that the receptor is assumed to be located on.
    b. On line A enter the lane edge to receptor distance correction factor based on data from the sketch of the location and the nomograph in Figure 28.

c. On line B enter the receptor concentration computed as the product of I-D and II-A; also, record the sum of the individual concentrations.

d. Assuming the receptor is located on the opposite side of the street (designate the side; e.g., west side of the street) enter the lane edge to receptor distance correction factor, again, based on data from the sketch of the location and Figure 28, on line C.

e. On line D enter the receptor concentration computed as the product of I-D and II-C; also, record the sum of the individual concentrations.

4. Part III:

   a. Indicate the side of the street on which the receptor is assumed to be located.

   b. In column b, first line, enter the total receptor concentration from II-A; on the second line, enter the total receptor concentration from II-D.

   c. In column b, enter the local vehicle mix correction factor, f_{vm} (see Section IV.B).

   d. Enter the corrected concentration computed as the product of columns a and b, in column c.

   e. Enter the maximum expected 1-hour average background concentration (see Section IV.G) in column d.

   f. Enter the total receptor concentration computed as the sum of columns c and d, in column e.

   g. Enter the 8-hour correlation factor (see Section IV.F) in column f.

   h. Enter the estimated maximum 8-hour average concentration expected computed as the product of columns e and f, in column g.

c. Step 3 - Upon completion of Step 2, above, the following data are entered for each location on the Hot Spot Verification Summary Sheet (Form 5):

1. The location and its assigned number.
2. The highest concentration computed in column g, Part III of the Work Sheet.

3. Subtask 2-c: Hot Spot Verification at Nonsignalized Intersections

a. Step 1 - Prepare a sketch of each location to be analyzed on a Hot Spot Verification Work Sheet - Field Data form; include the same data as was indicated in Step 1 for Hot Spot Verification at Signalized Intersections (see Section III.C.1.a).

b. Step 2 - The following pertains to the Hot Spot Verification Work Sheet - Nonsignalized Intersections (see Section III.B.3.e). These sheets should be completed for each location as follows:

1. Enter the appropriate data in the heading of the sheet.
2. Part I:
   a. Enter the street name and lane numbers for the streets controlled by STOP-signs, above line A.
   b. Enter the adjusted peak hour volumes (winter 1977-78) for each approach and departure lane, for each leg, on line A.
   c. Enter the lane capacity for each approach lane (see Section IV.E) on line B.
   d. Enter the volume-to-capacity ratio of each approach lane computed as the quotient of line A divided by line B, on line C.
   e. Enter the estimated cruise speed for each departure lane (see Section IV.D) on line D.
   f. Enter the lane concentrations on line E, computed from the volume-to-capacity ratio (line C) and the capacity (line B), utilizing Figure 29, for approach lanes, and the volume (line A) and cruise speed (line D) utilizing Figure 24, for the departure lanes.
3. Part II:
   a. Assuming the receptor is on the approach side of each street, enter the lane edge to receptor distance correction factor (based on the site sketch and the nomograph in Figure 28) on line A.

b. Enter the receptor concentration for each lane on line B, computed as the product of Part I.E and Part II.A; also, enter the sum of the individual lane concentrations.

c. Assuming the receptor is on the departure side of each street, enter the lane edge to receptor distance correction factor (based on the site sketch and the nomograph in Figure 28) on line C.

d. Enter the receptor concentration for each lane on line D, computed as the product of Part I.E and Part II.C; also, enter the sum of the individual lane concentrations.

4. Part III:

a. For each leg enter the computed receptor concentrations from Part II.B and Part II.D, in column a.

b. Enter the local vehicle mix correction factor, f_{vm} (see Section IV.B) in column b.

c. Enter the corrected concentration, computed as the product of columns a and b, in column c.

d. Enter the maximum expected 1-hour average background concentration (see Section IV.G) in column d.

e. Enter the total maximum 1-hour average concentration expected, computed as the sum of columns c and d, in column e.

f. Enter the 8-hour correlation factor (see Section IV.F) in column f.

g. Enter the maximum expected 8-hour average concentration, computed as the product of columns e and f, in column g.

c. Step 3 - Upon completion of Step 2, above, the following data are entered for each location on the Hot Spot Verification Summary Sheet (Form 5):

1. The location and its assigned number.

2. The highest concentration computed in column g, Part III of the work sheet.

3. Subtask 2-d: Hot Spot Verification for Special Cases

Special cases can be considered to include intersections under police control, facilities where the nature of traffic is such that the peak hour volumes represent a very high percentage of the ADT on the street (as a minimum, about 20 percent), or facilities where high volumes occur irregularly, such as at sports stadiums or other event-oriented facilities. Analysis of these may more appropriately consider the maximum impact on ambient air quality over a 1-hour period rather than the 8-hour period discussed previously. The process in this case would be exactly the same as that outlined for Task 2 except that the final computations would not involve application of the 8-hour correlation factor, and the standard for determining whether or not a hot spot was indicated would be 35 ppm rather than 9 ppm. It is noted that the preliminary screening process is not applicable to these special cases since it considers the 8-hour average concentration only.

REFERENCES

1. Highway Capacity Manual. Highway Research Board, National Academy of Sciences, National Research Council. Washington, D.C. Special Report No. 87. 1965.

SECTION IV

ADDITIONAL SCREENING INSTRUCTIONS

This section provides discussion of a number of issues relevant to hot spot screening. The intent is to clarify several points as well as to suggest techniques which perhaps will result in an increased measure of consistency in performing screening.

A. G/Cy

An important element in the screening of signalized intersections is the ratio of the green time allocated to each approach, to the total cycle length (G/Cy). For the preliminary screening process, G/Cy is "built into" the screening curves. However, for the hot spot verification process, G/Cy for each lane approaching a signalized intersection must receive careful attention.

The procedure for verifying hot spot potential at signalized intersections involves determining, first, the type of control mode utilized - that is, whether the signal is fixed time or actuated. If the installation utilizes a fixed-time controller, the determination of the lengths of both the green phase and total cycle, hence G/Cy, can be established through records such as permits or design specifications, or by timing the phases in the field. For actuated systems, the G/Cy for each approach can be estimated by apportionment of the green time among the individual phases based on the critical volume demand occurring during each phase. Where obvious differences exist in the critical lane capacities of conflicting approaches, the volume to capacity ratio (V/C) should be utilized in apportioning green time to account for these differences. For example, if the critical volume, V_1, of an approach is 400 vehicles and the capacity, C_1, is 800 vehicles per hour (vph), while the opposing critical volume, V_2, and capacity, C_2, are 200 vehicles and 400 vph, respectively, the "weighted" apportionment of green time for V_1 traffic is:

$$\frac{G_1}{\Sigma G} = \frac{\frac{V_1}{C_1}}{\frac{V_1}{C_1} + \frac{V_2}{C_2}} = \frac{V_1C_2}{V_1C_2 + V_2C_1} = \frac{(400)(400)}{(400)(400) + (200)(800)} = 0.5$$

In general terms, the ratio of green time for phase i to the total green time of a signal cycle involving n phases, is:

$$\frac{G_i}{\Sigma G} = \frac{\frac{V_i}{C_i}}{\Sigma_i^n \frac{V_i}{C_i} + \ldots \frac{V_n}{C_n}} \qquad (2)$$

For all types of signal systems where actuated pedestrian phases are provided, an estimate must be made of the extent to which these phases are utilized, and their net impact reflected. Essentially, the impact of pedestrian phases will be to reduce the total green time available, therefore reducing the G/Cy for each approach. Field observations should provide a sufficient basis for estimating the usage of the pedestrian phases in general terms such as: on call 10 cycles per hour, etc.

Special consideration must also be given to locations where continuous right turns are permitted. If exclusive turn lanes are provided, the procedure is to use Figure 24 for computing carbon monoxide concentrations resulting from traffic utilizing the turn lane. Where free right turns are permitted from a through lane, however, it is likely that access to the right turn will occasionally be blocked by through traffic during a red phase. In this case, Figure 23 should be used for computing carbon monoxide concentrations resulting from traffic in the lane, although an adjustment should be made to the lane's G/Cy to account for its increased throughput capability attributable to the free right turn. The basis for this adjustment should be field observations that focus on estimating the extent to which the lane remains open to vehicles making the right turn, during the approach's red phase.

B. LOCAL VEHICLE MIX CORRECTION FACTOR

The nomographs developed for hot spot verification assume a vehicle mix of 88 percent light-duty vehicles and 12 percent light-duty trucks. However, for actually verifying hot spot potential at a particular location the actual vehicle vehicle-type distribution should be determined and appropriate adjustments made to the concentrations computed from the nomographs. This adjustment is made by applying a correction factor, f_{vm}, to the concentrations computed from the nomographs.

In order to determine the appropriate value for f_{vm} the actual local vehicle mix must be determined. Essentially, this involves identifying the relative proportions of four vehicle types within the traffic stream, including:

- light-duty vehicles (passenger cars)
- light-duty trucks (up to about 6000 pounds GVW)
- heavy-duty, gasoline-powered vehicles
- heavy-duty, diesel-powered vehicles

The correction factor, f_{vm}, is determined through the following equation:

$$f_{vm} = \frac{1}{24.12}\left[(\rho_{ldv})(i_{ldv}) + (\rho_{ldt})(i_{ldt}) + (\rho_{hdv})(i_{hdv}) + (\rho_{hddv})(i_{hddv})\right] \quad (3)$$

where ρ_{ldv} = percent LDV's in the vehicle population x 10^{-2}

ρ_{ldt} = percent LDT's in the vehicle population x 10^{-2}

ρ_{hdv} = percent HDV's in the vehicle population x 10^{-2}

ρ_{hddv} = percent HDDV's in the vehicle population x 10^{-2}

i_{ldv} = average emissions index for LDV's; = 22.5

i_{ldt} = average emissions index for LDT's; = 36.0

i_{hdv} = average emissions index for HDV's; = 114.7

i_{hddv} = average emissions index for HDDV's; = 28.7

For areas where so-called "tail pipe controls" such as retrofit or inspection and maintenance are anticipated, adjustments should be applied accordingly to account for reduced emissions rates. Since these types of controls are often specific to a particular classification of vehicle, such as retrofitting only HDV's or applying inspection and maintenance to LDV's only, the adjustments should be applied only to the classification(s) impacted. In applying the adjustments, the expected reduction in emissions (expressed in percent x 10^{-2}) attributable to the control measure, is applied to the emissions index for the vehicle category affected. For instance, if a particular configuration of inspection and maintenance is expected to be applied to LDV's and LDT's only, and the expected reduction overall in emissions from each is 9 percent and 11 percent, respectively, the adjustments involved are:

for LDV's: Emissions index (i_{ldv}) from the previous page is 22.5 grams/mile. Effectiveness of control measure is 9 percent x $10^{-2} = 0.09$.
Corrected emissions factor (i'_{ldv}) is:

$$i'_{ldv} = (i_{ldv})(1.0 - 0.09) = (22.5)(0.91) = 20.5 \text{ grams/mile.}$$

for LDT's: Emissions index (i_{ldt}) from the previous page is 36.0 grams/mile. Effectiveness of control measure is 11 percent x $10^{-2} = 0.11$.
Corrected emissions factor (i'_{ldt}) is:

$$i'_{ldt} = (i_{ldt})(1.0 - 0.11) = (36.0)(0.89) = 32.0 \text{ grams/mile.}$$

To account for the effects of the inspection and maintenance, then, the emissions indices i'_{ldv} and i'_{ldt} are substituted for i_{ldv} and i_{ldt}, respectively, in Equation (2).

C. REASONABLE RECEPTOR SITE

1. Definition of Reasonable Receptor

The following is an excerpt from a U.S. Environmental Protection Agency report entitled Guidelines for Air Quality Maintenance Planning and Analysis, Volume 9: Evaluating Indirect Sources.

- Receptor Site - A location where it is of interest to estimate ambient CO concentrations. In general terms, analysis should center on reasonable locations in the vicinity of that portion of the traffic network (e.g., parking lot, access roads, intersections) where the combined impact of the proposed source and other traffic is likely to result in the highest traffic demand and/or most traffic congestion. Definition of "reasonable" depends on the legal interpretation of the word "ambient." "Ambient" is interpreted as meaning that portion of the atmosphere, external to buildings, to which the general public has access. The primary standards for CO imply that reasonable sites are required to be in locations to which the general public (note: not necessarily any specific individual) has access. The recommended procedure for selecting such sites is through joint review by the reviewing agency and applicant of maps and plans of the area and facility which are required as part of the indirect source or parking management application. To clarify what might generally be regarded as reasonable or unreasonable receptor sites, a few examples are cited below. It should be strongly emphasized that these examples only suggest what is generally expected to be the case. If the review of a specific application reveals that a site which may ordinarily be unreasonable is, in fact, reasonable in a specific case (or vice versa) then, of course, the specific ruling would supersede this general guidance.

a. Examples of Reasonable Receptor Sites -

1. All sidewalks where the general public has access on a more or less continuous basis are reasonable receptor sites.

2. A vacant lot in which a neighboring facility is planned and in whose vicinity the general public (including employees if the neighboring facility is not being built for the prime purpose of traffic control) would have access continuously is a reasonable receptor site.

3. Portions of a parking lot to which pedestrians have access continuously are reasonable receptor sites.

4. The vicinity of parking lot's entrances and exits is a reasonable receptor site, providing there is an area nearby, such as a public sidewalk, residences or structures (e.g., an auto service center at a shopping center) where the general public is likely to have continuous access.

5. The property lines of all residences, hospitals, rest homes, schools, playgrounds, and the entrances and air intakes to all other buildings are reasonable receptor sites.

From a practical standpoint it is not possible to generate universal guidelines that provide detailed instructions for determining the exact location of a reasonable receptor. For the purposes of hot spot verification the most practical guidance that can be given is to assume the receptor to be located at the centerline of adjacent sidewalks or at the right-of-way limit if there are no sidewalks adjacent to the facility. The key is to keep in mind that the receptor should represent the location proximate to the highway or street where the general public has access.

2. Lane Edge to Receptor Distance

From Figures 25, 28, and 30, it is obvious that carbon monoxide concentrations diminish rapidly with distance from the emissions source. This being the case, it is important to establish the proximity of the receptor with respect to the edge of each travel lane on an adjacent roadway. First, if the receptor is identified as being a sidewalk, the center line of the sidewalk should be considered as the actual receptor site. From this point, the distance to the near edge of the traveled portion of each lane should be determined and using these distances in conjunction with Figures 25, 28, and 30, appropriate correction factors determined.

D. CRUISE SPEED

From Figure 24 it can be seen that the cruise speed downstream of the intersection must be determined in order to compute concentrations from departing vehicles. Generally, cruise speed will be a function of the type of facility, proximity of downstream signals and whether these signals are coordinated, interference from pedestrians or other traffic, roadway alignment, etc. Estimates of the downstream cruise speed, then, can be made by categorizing locations according to the extent that friction can be expected in the traffic stream, and relating these general categories to speed ranges. Table 1 suggests criteria for selecting appropriate cruise speeds for use with Figure 24. Obviously, selection of the cruise speed element is somewhat subjective; however, utilizing the general criteria outlined in Table 1, in conjunction with field observations and a general familiarity with the area being analyzed, should result in a reasonable estimate of these speeds.

Table 1. CRITERIA FOR SELECTION OF CRUISE SPEED VALUES

General location	Operating characteristics	Cruise speed range (mph)
Central business district; Fringe business district	Much interference and friction from pedestrians or parking and unparking vehicles; closely spaced intersections; individual vehicle speed nearly always controlled by speed of the entire traffic stream;	15 - 20
Outlying business district; Dense residential/commercial land use;	Occasional interference and friction from pedestrians or parking and unparking vehicles; nearby intersections occasionaly restrict flow; individual vehicle speed somewhat controlled by speed of of entire traffic stream;	20 - 30
Outlying and residential residential/commercial land use;	Infrequent interference or friction from pedestrians or maneuvering vehicles; no interference from downstream intersections; speed of individual vehicle mildly influenced by speed of traffic stream.	25 - 35

E. CAPACITY

1. Preliminary Screening

In the preliminary screening process estimates of lane capacity are required for streets and highways where uninterrupted flow conditions prevail or are assumed to prevail.

Lane capacity can be estimated from the expression:

$$C = 2{,}000\ W\ T_c$$

where C = lane capacity
W = adjustment for lane width and lateral clearance
T_c = truck factor

The appropriate values of W and T_c can be determined from the 1965 Highway Capacity Manual. If data is not available regarding the parameters required for determining W and T_c, it is suggested that national or regional averages be used. These data can be obtained from agencies such as the Automobile Manufacturers Association (AMA) or the American Association of State Highway and Transportation Officials (AASHTO) for traffic composition; and from state highway inventories or design standards for physical characteristics such as lane widths and lateral clearances.

2. Hot Spot Verification

The same procedure is utilized for estimating lane capacity as described above except it is reasonable to expect that the actual physical and operating characteristics (lane widths, clearances, percent trucks and buses, etc.) can be determined rather than assuming or estimating these.

Analysis of the approach lane capacity of streets controlled by STOP signs has not received wide attention. Research that has been documented indicates that the capacity of a STOP-sign controlled lane is a function of the capacity and volume demand of the through street. From this general observation, the following expression was developed to provide a means for estimating approach lane capacity:

$$C_2 = (0.75)(C_1 - V_1)$$

where C_2 = the capacity of the STOP-sign controlled approach

C_1 = the average lane capacity of the major through street in the critical direction.

V_1 = average lane volume of the major through street in the critical direction.

In the above, critical direction means the roadway direction with the highest average lane volume to capacity ratio (V/C).

F. 8-HOUR CORRELATION FACTOR

The screening guidelines incorporate techniques based upon the calculation of 1-hour average concentrations of carbon monoxide from peak hour traffic volumes. Because the 8-hour standard is more often violated then the 1-hour standard, it is necessary to provide a means for developing estimates of the 8-hour average concentration from the calculated 1-hour average.

Analyses of air quality data from a number of monitoring stations in several cities in the northeastern U.S. were conducted in order to determine whether a definite relationship could be established between 1-hour average and 8-hour average concentrations. These analyses were based on examining the relationship between maximum 1-hour average concentrations, and maximum 8-hour average concentrations where the 8-hour averaging period included the maximum 1-hour average. These analyses indicated that the average ratio of 8-hour average concentrations to 1-hour average concentrations ranged in value from about 0.5 to 0.8, with an average of about 0.7. Further, analysis of the relationship where 1-hour concentrations were 10 ppm or more, indicated that this ratio was slightly lower with with a range generally of from 0.6 to 0.7. Thus, a value of 0.7 was selected as being representative of the 8-hour to 1-hour ratio. It is emphasized that if sufficient local air quality data are available, these should be analyzed to determine whether some other value representing the 8-hour to 1-hour ratio might be more appropriate for that location.

G. BACKGROUND CONCENTRATION

Studies have indicated the existence of a background concentration of carbon monoxide occurring throughout urban and suburban areas as a result of dispersion of the pollutant at or near ground level. Determination of the actual value of the maximum expected background concentration involves long term local monitoring as described in the Guidelines for Air Quality Maintenance Planning and Analysis, Volume 9: Evaluating Indirect Sources.

It is very likely that in many instances local monitoring will not be possible. Owing to this a value representing background concentrations was developed, based on limited analyses of data for three cities in New England. The value determined, 5.0 parts per million (ppm), is based in part on air quality modeling using a diffusion model (APRAC) and meteorological data covering a 1-year period. These analyses indicated that the average maximum background concentration (8-hour average) computed for 20 locations in each city ranged from 2.5 ppm to 5.1 ppm during 1973 to 1974. Extrapolating these figures to 1977 to 1978 would result in a range of about 1.5 ppm to 3.1 ppm. Using the higher value, 3.1 ppm, the maximum 1-hour average background concentration can be estimated through the 1-hour/8-hour correlation factor discussed previously. Applying this factor results in an estimated 1-hour average background concentration of about 4.4 ppm or (conservatively), say 5 ppm. Thus, the 5 ppm value is recommended unless data are available to develop specific local background estimates.

H. DEFINITIONS

Several terms used in this guideline are defined below to clarify their intended meaning.

1. Complex Intersections/Special Cases

This term is used in the preliminary screening process and is defined as an intersection where the volumes, turning movements, geometry, or number of approaches, result in a signal cycle comprising more than two phases. An intersection can be considered complex if pedestrian activity is such that traffic flow is interrupted during most cycles by pedestrian crossings.

A special case refers to either a signalized or nonsignalized intersection where conditions are such that the preliminary screening technique becomes inappropriate for evaluating hot spot potential. Examples of special cases include (1) signals used only for certain events such as during peak-hours only, or during work-shift changes if the location is in the vicinity of a major industrial or office complex; (2) where signals are manually operated or pre-empted in favor of traffic direction by police personnel; (3) where signals are utilized for pedestrian crossing protection only; and (4) where police control is utilized at nonsignalized intersections.

2. Congested/Noncongested Areas

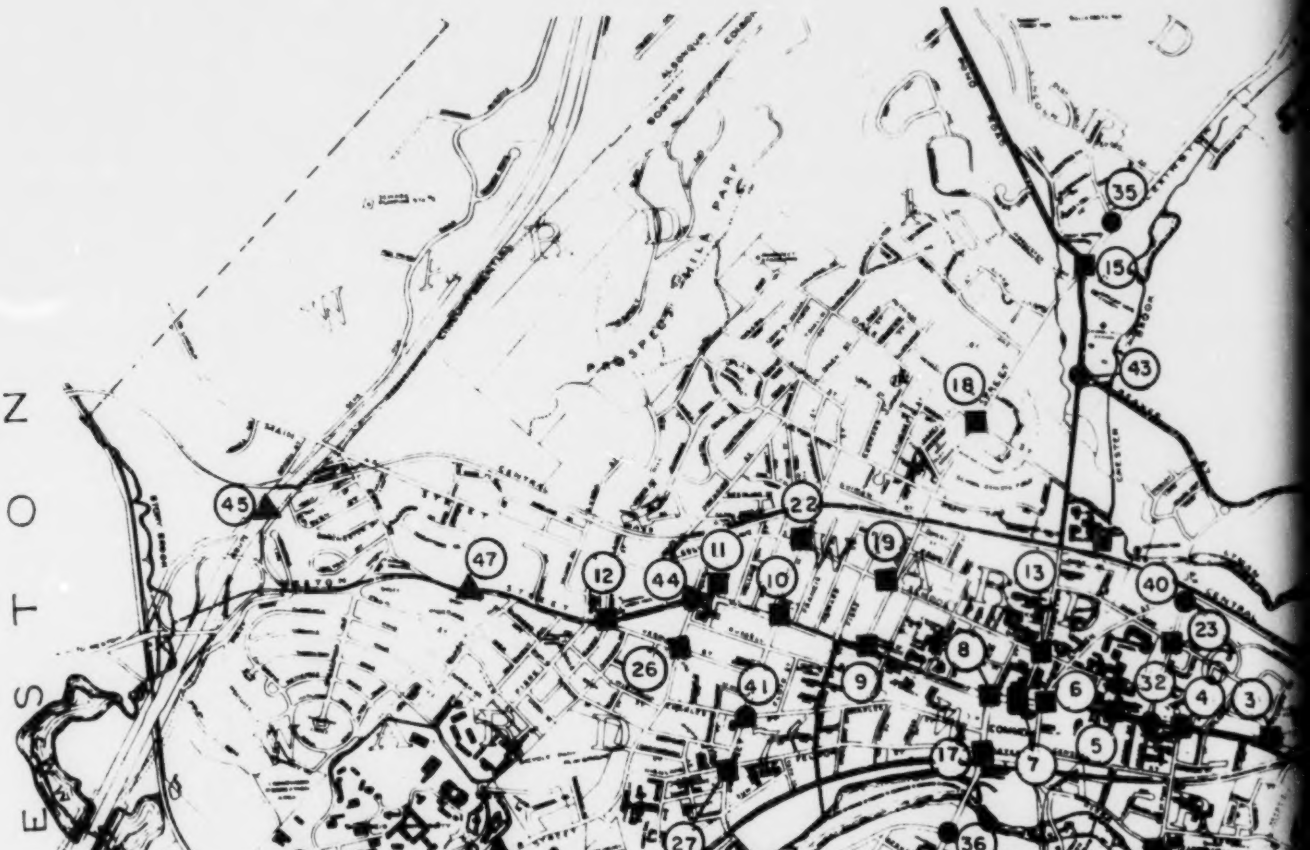
These terms are utilized in the preliminary screening procedure to indicate whether or not significant interference to traffic departing from an intersection can be expected. For congested areas, downstream cruise speeds will be fairly low (less than about 20 to 25 miles per hour) with some interruptions occurring. In noncongested areas, however, few, if any, interruptions to departing traffic will occur, and downstream cruise speeds will be somewhat higher (at least 25 miles per hour).

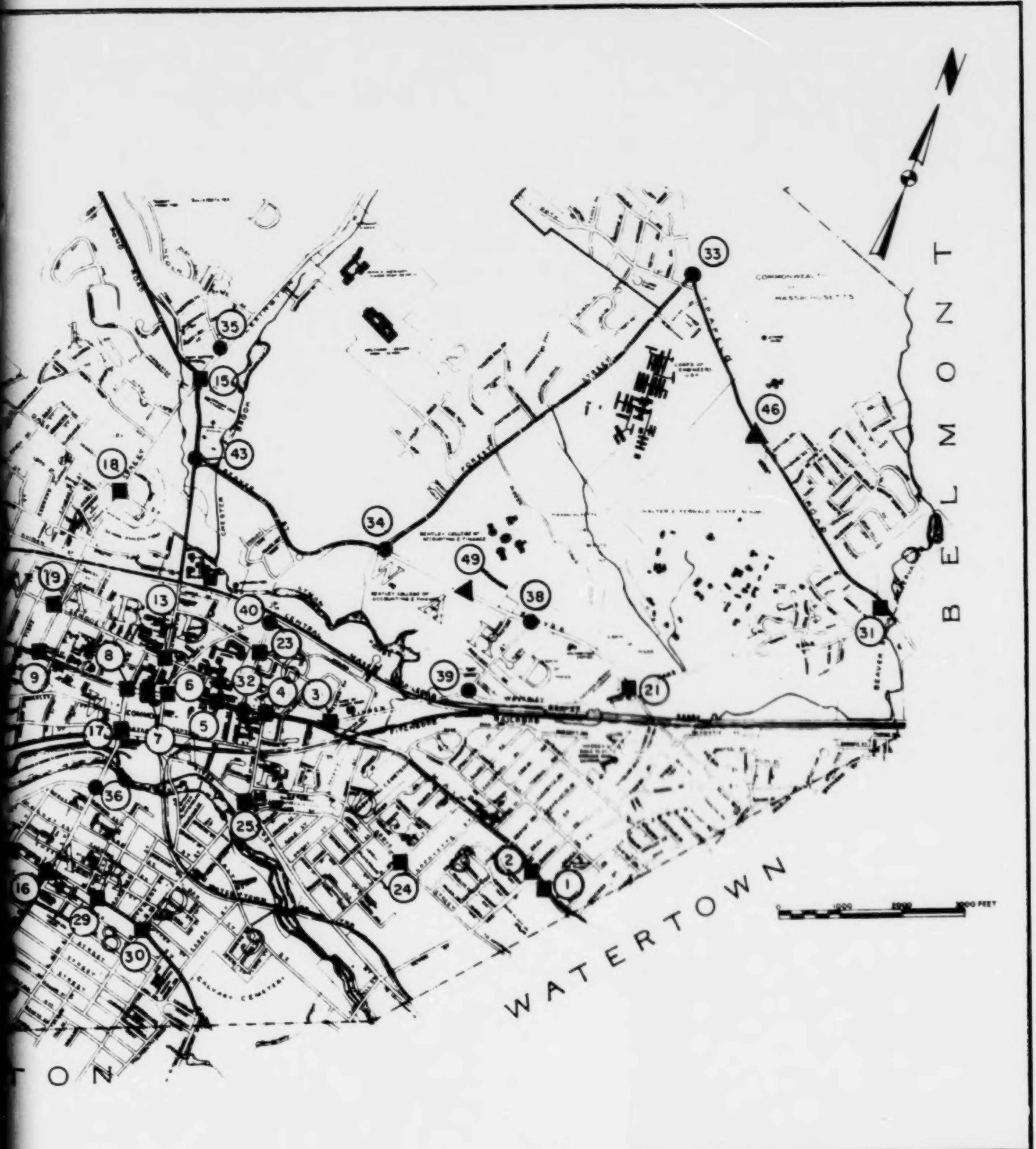
APPENDIX A

BASE MAPS DEVELOPED FOR THE SCREENING OF WALTHAM, MASSACHUSETTS

Presented in this appendix is a series of maps developed for use during the screening of the City of Waltham. These were prepared by modifying a set of maps provided by the Massachusetts Department of Public Works. Included are the following:

Title	Figure numbers
Hot Spot Analysis Sites	Figures A1-a, A1-b
Traffic Volume Count Locations	Figures A2-a, A2-b
Traffic Flow Map	Figures A3-a, A3-b

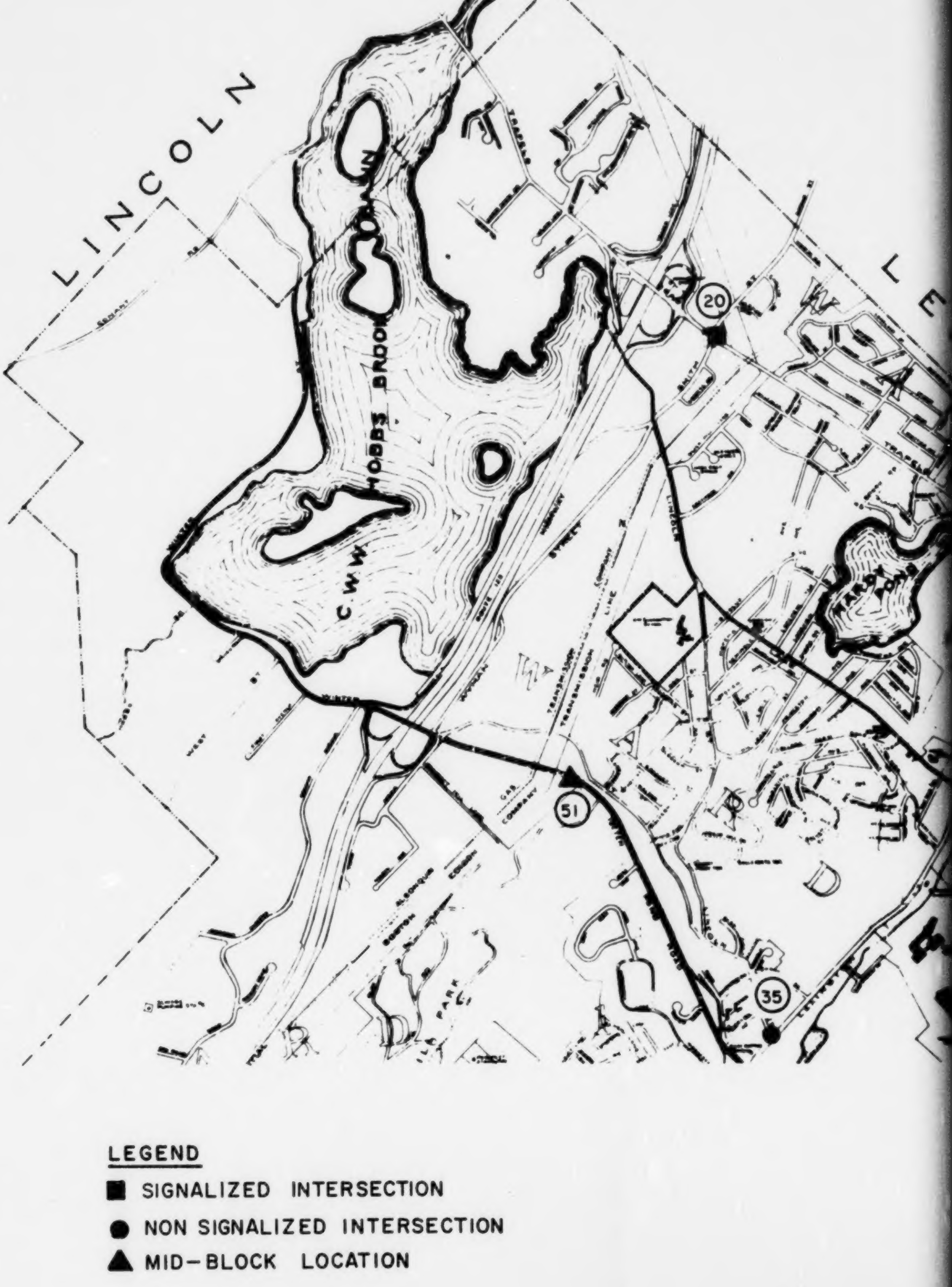

WESTON
NEWTON
45
47
22
19
11
12
44
10
13
40
23
26
8
9
6
32
4
3
41
5
17
7
36
27
48
25
42
28
16
29
50
30
37
35
15
43
18
PROSPECT
MOUNT FEAKE CEMETERY
CALVARY CEMETERY
CHARL
LEGEND
■ SIGNALIZED INTERSECTION
● NON SIGNALIZED INTERSECTION
▲ MID-BLOCK LOCATION

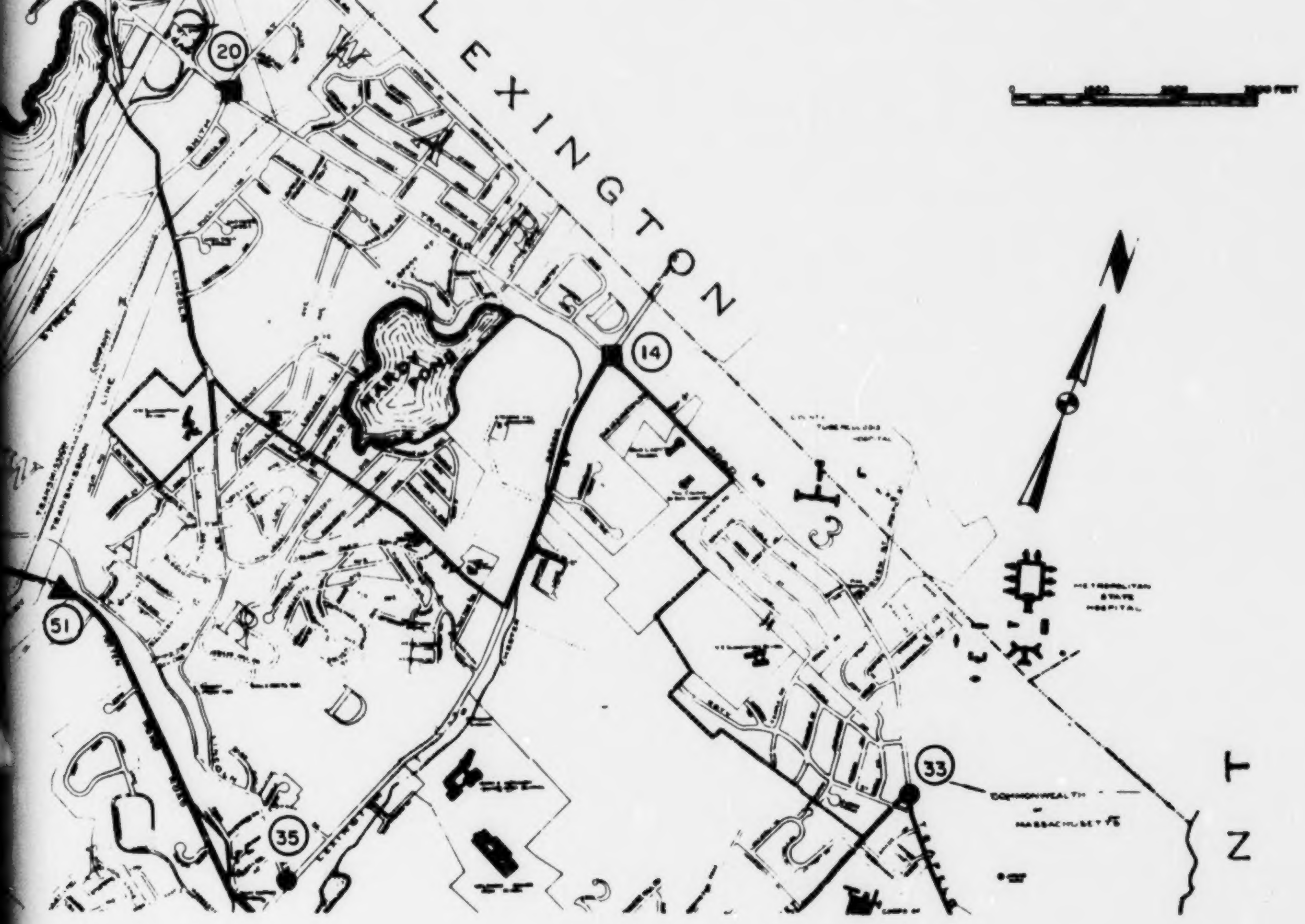

33
35
15
43
46
18
34
49
38
19
13
40
23
8
9
6
32
4
3
39
21
31
17
7
5
36
25
2
1
24
16
29
30
COMMONWEALTH OF MASSACHUSETTS
CORPS OF ENGINEERS U.S.A.
WALTER E. FERNALD STATE SCHOOL
BENTLEY COLLEGE OF ACCOUNTING & FINANCE
CALVARY CEMETERY
BELMONT
WATERTOWN
TON
0
1000
2000
3000 FEET

GCA/TECHNOLOGY DIVISION ●● ▲

HOT SPOT ANALYSIS SITES
WALTHAM, MASSACHUSETTS

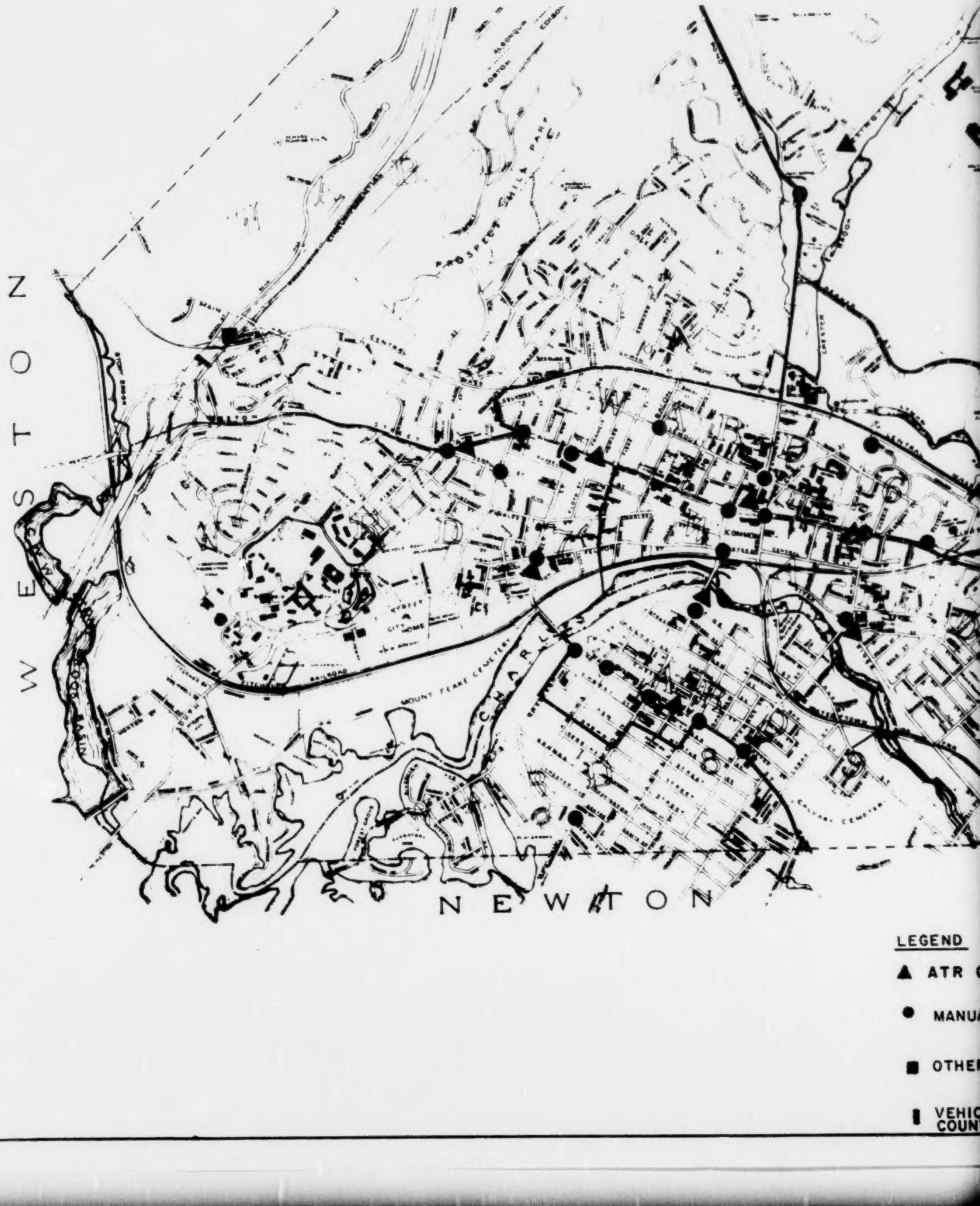
NOV. 1975	FIGURE A-1A

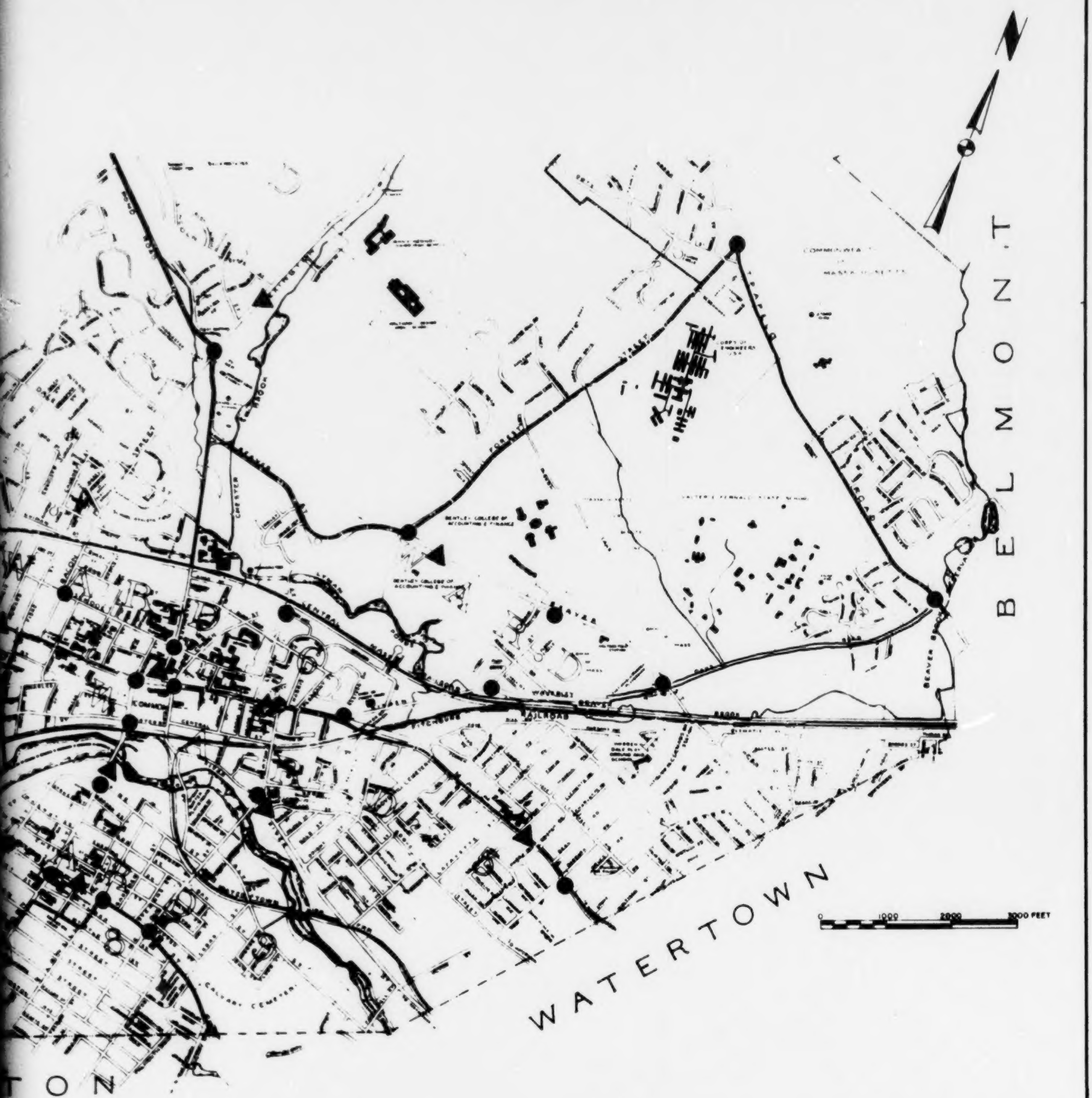

LINCOLN
LE
C.W.W.
HOBBS BROOK
HARDY POND
20
51
35
LEGEND
■ SIGNALIZED INTERSECTION
● NON SIGNALIZED INTERSECTION
▲ MID-BLOCK LOCATION


LEXINGTON
20
14
51
35
33
HARDY POND
COMMONWEALTH OF MASSACHUSETTS
METROPOLITAN STATE HOSPITAL
COUNTY TUBERCULOSIS HOSPITAL
0
1000
2000
3000 FEET
N

GCA/TECHNOLOGY DIVISION ●●▲
HOT SPOT ANALYSIS SITES
WALTHAM, MASSACHUSETTS

NOV. 1975 | FIGURE A-1B


W E S T O N
N E W T O N
PROSPECT
CHARLES
MOUNT FEAKE CEMETERY
CITY HOME
RAILROAD
LEGEND
ATR C
MANUA
OTHER
VEHIC
COUNT


BELMONT
WATERTOWN
TON
0
1000
2000
3000 FEET

LEGEND

- ▲ ATR COUNTS
- ● MANUAL COUNTS
- ■ OTHER COUNTS
- ▮ VEHICLE MIX CLASSIFICATION COUNTS

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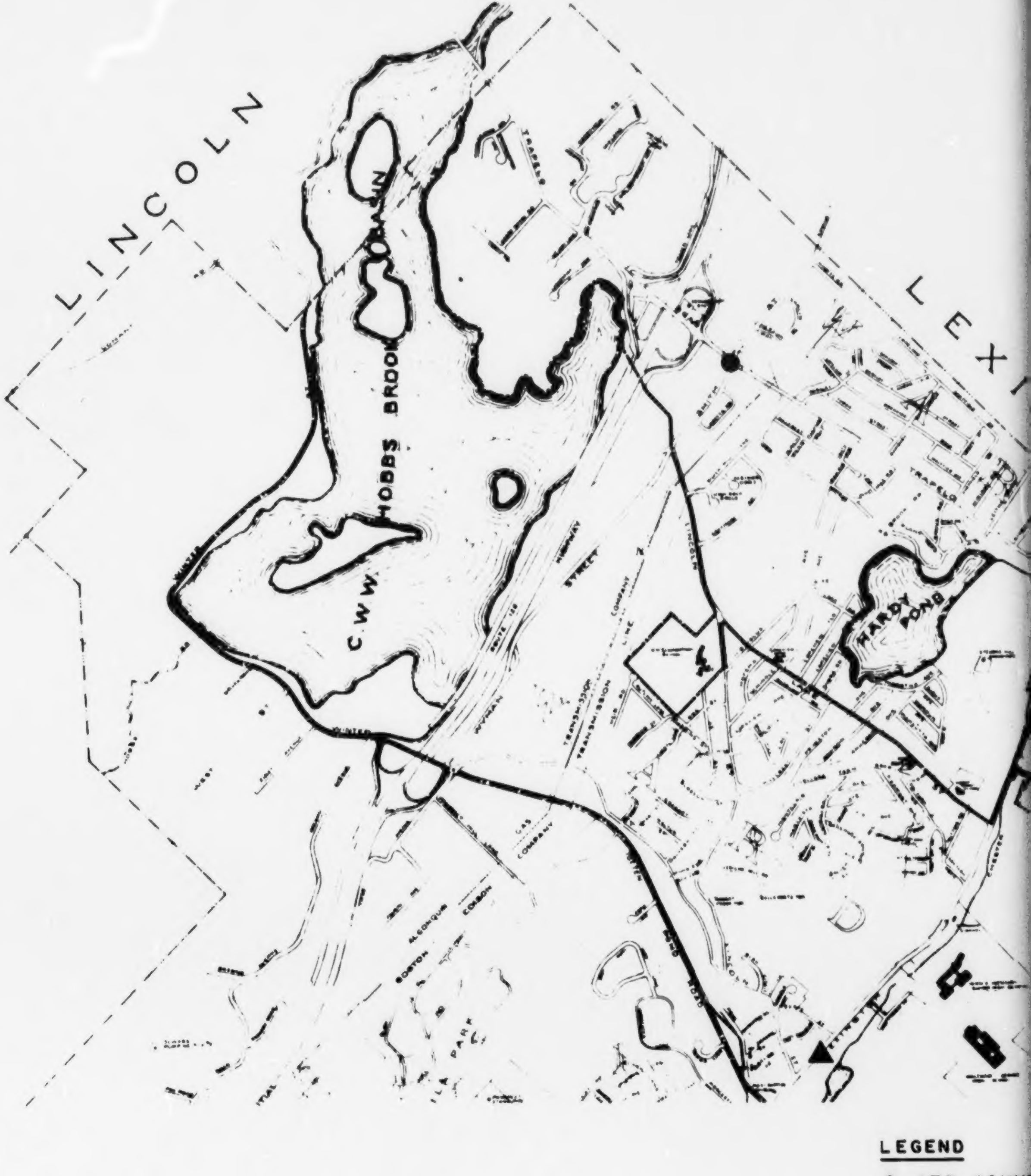
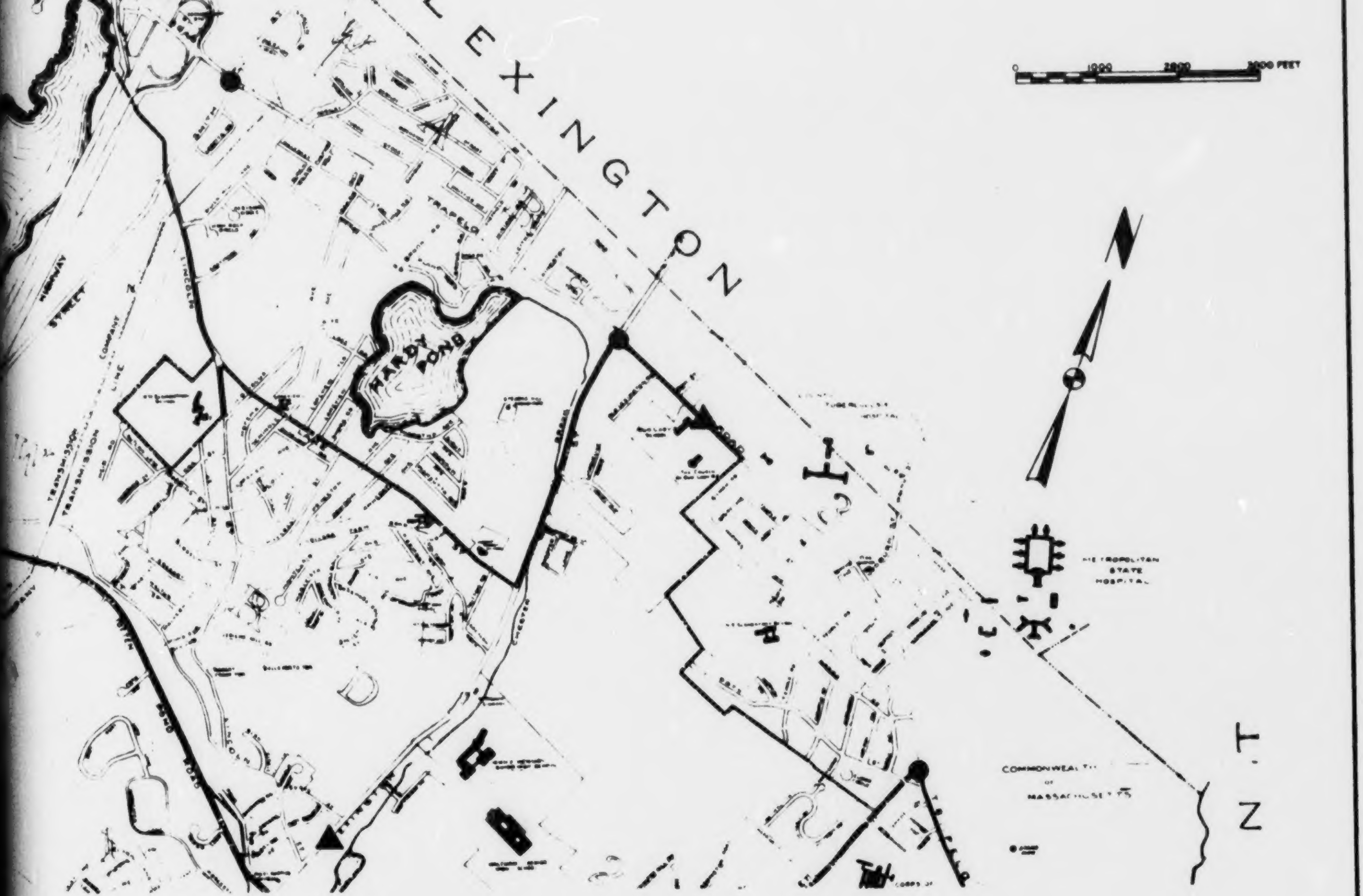
TRAFFIC VOLUME COUNT LOCATIONS
WALTHAM, MASSACHUSETTS

NOV. 1975

FIGURE A-2A



LINCOLN
LEXI
HOBBS BROOK
BASIN
C.W.W.
HARDY POND
LEGEND
▲ ATR COUNT
● MANUAL CO
■ OTHER CO
▮ VEHICLE
COUNTS


LEXINGTON
HARDY POND
METROPOLITAN STATE HOSPITAL
COMMONWEALTH OF MASSACHUSETTS
0
1000
2000
3000 FEET
N
T.
N

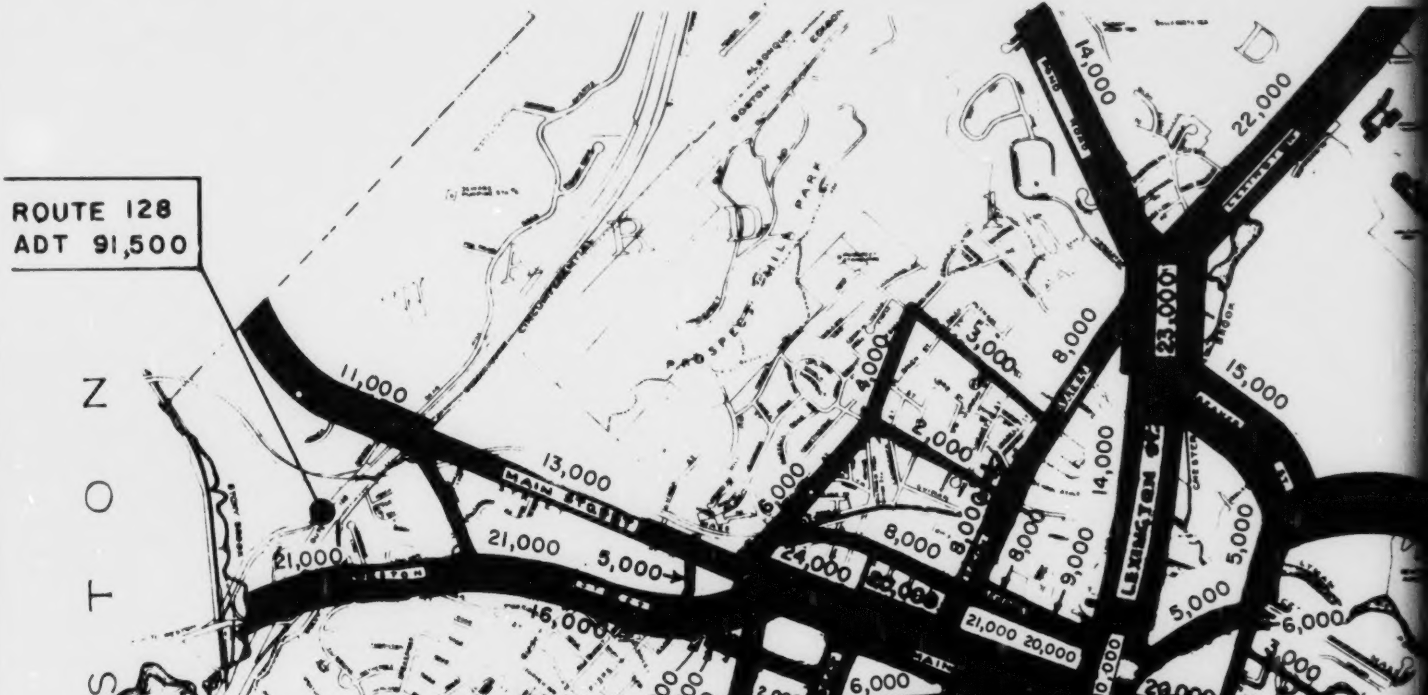
LEGEND

- ▲ ATR COUNTS
- ● MANUAL COUNTS
- ■ OTHER COUNTS
- ▮ VEHICLE MIX CLASSIFICATION COUNTS

GCA/TECHNOLOGY DIVISION ●●▲

TRAFFIC VOLUME COUNT LOCATIONS
WALTHAM . MASSACHUSETTS

NOV. 1975	FIGURE A-2B


ROUTE 128
ADT 91,500
WESTON
NEWTON
MAIN STREET
HIGH ST.
MOODY
LEXINGTON ST.
NEWTON
COMMON
PROSPECT
CITY HOME
RAILROAD
MOUNT FEAKE CEMETERY
CEMETERY
BASIN
11,000
13,000
21,000
21,000
5,000
16,000
24,000
20,000
21,000
20,000
6,000
4,000
3,000
2,000
8,000
8,000
8,000
9,000
14,000
8,000
14,000
22,000
23,000
15,000
5,000
5,000
6,000
3,000
18,000
9,000
10,000
10,000
20,000
14,000
6,000
10,000
2,000
6,000
6,000
15,000
3,000
10,000
16,000
7,000
16,000
11,000
11,000
16,000
11,000
15,000
9,000
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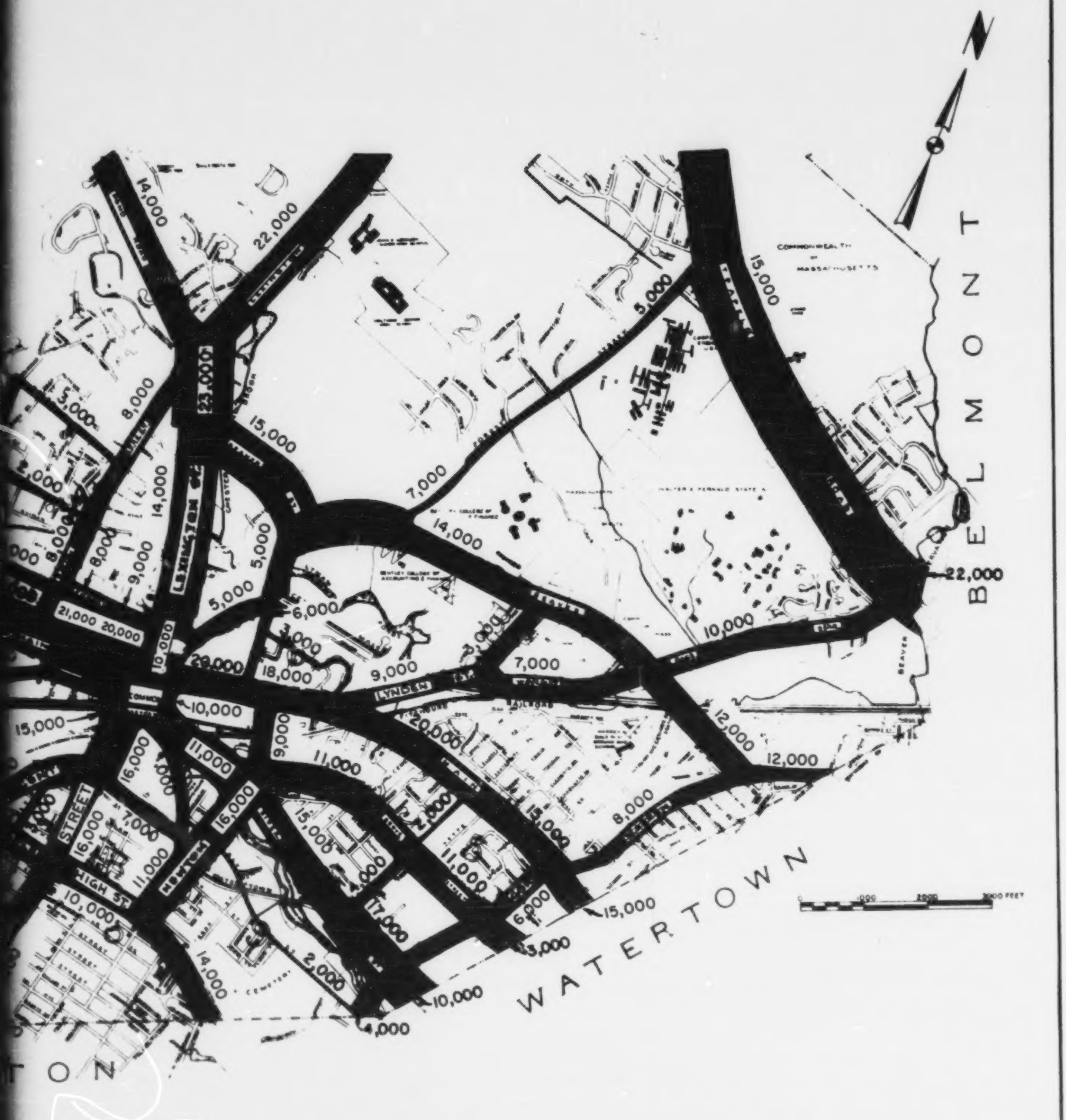
4,000
14,000
2,000
4,000


BELMONT
WATERTOWN
TON
COMMONWEALTH OF MASSACHUSETTS
WALTER E. FERNALD STATE
BENTLEY COLLEGE OF ACCOUNTING & FINANCE
LEXINGTON ST.
LYNDEN ST.
STREET
HIGH ST.
NEWTON
COMMON
BEAVER
RAILROAD
CEMETERY
0 1000 2000 3000 FEET
14,000
22,000
23,000
15,000
5,000
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14,000
7,000
14,000
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9,000
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12,000
12,000
16,000
7,000
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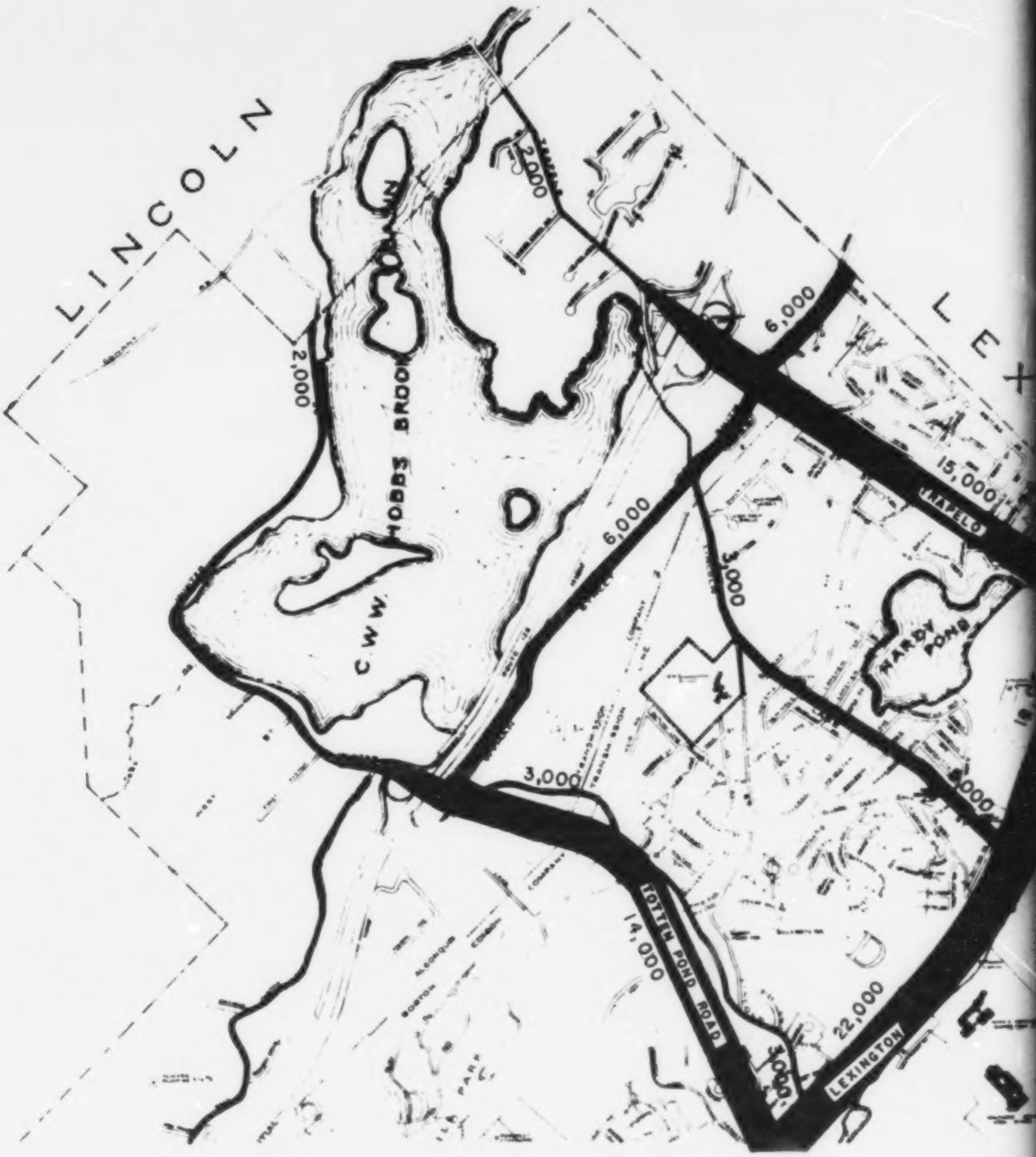
16,000
15,000
15,000
11,000
8,000
10,000
14,000
2,000
17,000
6,000
15,000
3,000
10,000
4,000
EST. ADT SCALE
25,000
15,000
5,000

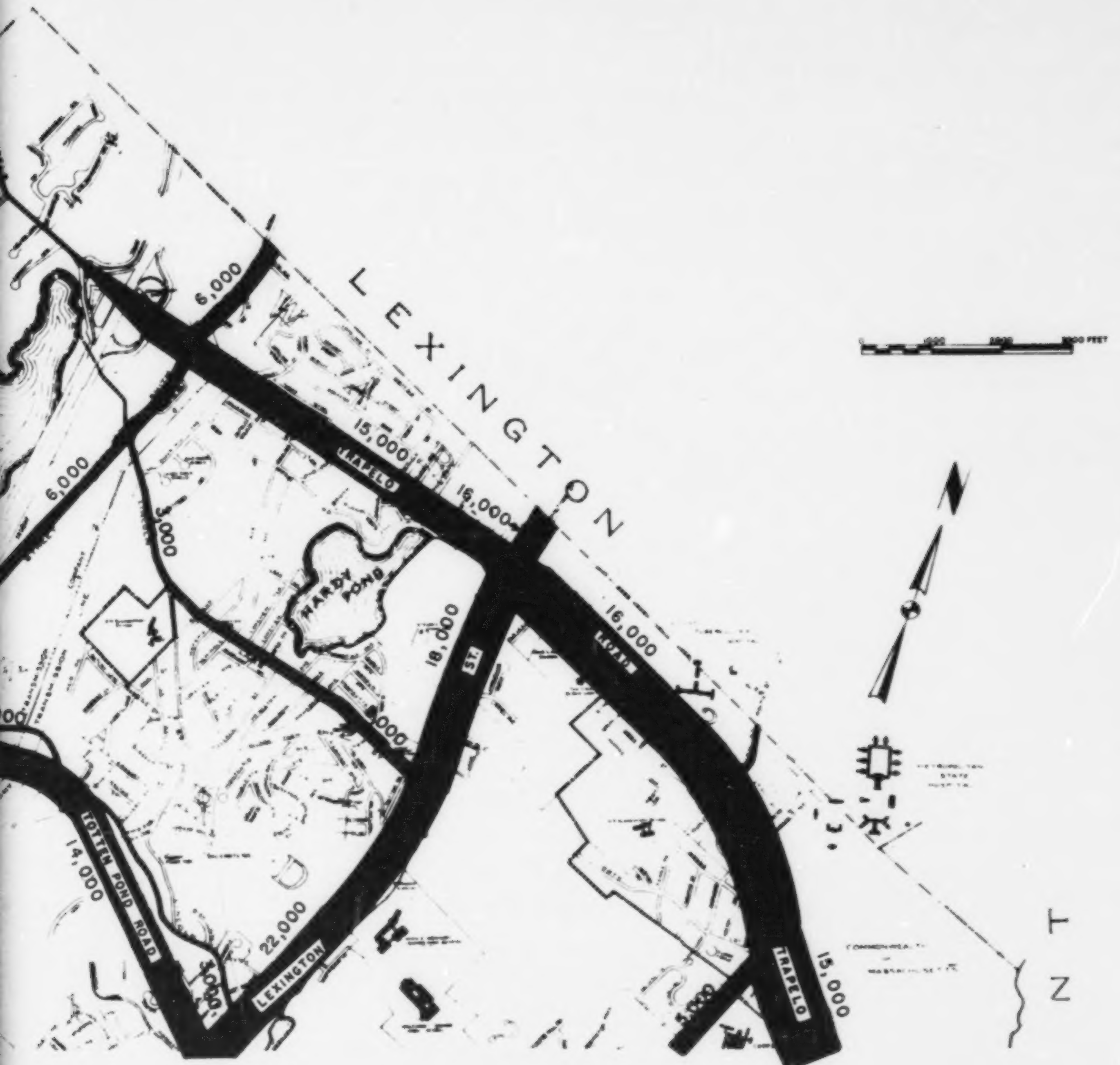
GCA/TECHNOLOGY DIVISION ●●▲

TRAFFIC FLOW MAP
WALTHAM, MASSACHUSETTS

NOV. 1975

FIGURE A-3A


LINCOLN
LEX
2,000
2,000
6,000
15,000
TRAPELO
HOBBS BROOK
C.W.W.
6,000
3,000
HARDY POND
3,000
3,000
TOTTEN POND ROAD
14,000
3,000
22,000
LEXINGTON


LEXINGTON
6,000
6,000
15,000
TRAPELO
16,000
3,000
HARDY POND
16,000
ROAD
18,000
ST.
8,000
TOTTEN POND ROAD
14,000
22,000
LEXINGTON
3,000
5,000
TRAPELO
15,000
0 1000 2000 3000 FEET
N
COMMONWEALTH OF MASSACHUSETTS
T
N

EST. ADT SCALE

—25,000—
—15,000—
—5,000—

GCA/TECHNOLOGY DIVISION

TRAFFIC FLOW MAP
WALTHAM, MASSACHUSETTS

NOV. 1975

FIGURE A-3B

APPENDIX B

EXAMPLES OF THE PRELIMINARY SCREENING PROCEDURE

This appendix provides examples of completed forms from a preliminary screening effort undertaken in the City of Waltham, Massachusetts, as part of the development of the preliminary screening procedure. Shown in this appendix are the data sheets for 14 of the 51 separate locations analyzed; included are five signalized intersections, five locations where conditions of uninterrupted flow prevail, and four nonsignalized intersections. The location numbers appearing on the Initial Screening Summary Sheet correspond to the numbered locations shown on the Hot Spot Analysis Sites map, presented in Figures A-1a and A-1b in Appendix A.

INITIAL SCREENING SUMMARY SHEET

page 1 of 6

City/Town: WALTHAM State: MASSACHUSETTS

Analysis By: ______ (name) ______ (title) Date: ______

Approved By: ______ (name) ______ (title) Date: ______

Location	Type	Hot Spot Indicated or Detailed Analysis Required	
		Yes	No
15. Lexington St. at Totten Pond Rd. and Bacon St.	Signalized Intersection	X	
18. Bacon St. at Dale St.	Signalized Intersection		X
19. Bacon St. at School St.	Signalized Intersection	X	
22. Hammond St. at Columbus St.	Signalized Intersection		X
29. High St. at Lowell St.	Signalized Intersection	X	
32. Main St. at Lyman St.	Nonsignalized Intersection		X
35. Lexington St. at Lake St.	Nonsignalized Intersection		X
37. Moody St. at Crescent and Derby Streets	Nonsignalized Intersection	X	
43. Weston St. at South St.	Nonsignalized Intersection	X	
45. Route 128 at Main St.	Uninterrupted Flow	X	
46. Trapelo Rd. between Forest St. and Waverly Oaks Rd.	Uninterrupted Flow	X	
47. Weston St. between Route 128 and Eddy St.	Uninterrupted Flow	X	
48. South St. between Brandeis University and Waltham Hospital	Uninterrupted Flow		X
49. Beaver St. between Forest St. and Waverly Oaks Rd.	Uninterrupted Flow		X

PRELIMINARY SCREENING WORK SHEET- SIGNALIZED INTERSECTIONS

page 2 of 6

City/Town: WALTHAM State: MASSACHUSETTS

Analysis By: ______ (name) ______ (title) Date: ______

Approved By: ______ (name) ______ (title) Date: ______

Part I Location: Lexington St @ Totten Pond Rd & Bacon St.

Part II Congested Area? ____Yes; __X__No

Part III Complex Intersection or Special Case? __X__Yes; ____No; If yes, enter location on Initial Screening Summary Sheet and proceed to next intersection; if no, proceed with Part IV.

Part IV Analyze each leg seperately on the form, below.

Leg under analysis			Cross-street data							
			Street: ______ Leg: ______				Street: ______ Leg: ______			
a Designation	b Adjusted ADT (1977-78)	c Configuration	d Adjusted ADT (1977-78)	e Configuration	f Figure/curve used	g Hot spot indicated?	h Adjusted ADT (1977-78)	i Configuration	j Figure/curve used	k Hot spot indicated?
			Street: ______ Leg: ______				Street: ______ Leg: ______			

Part I Location: Bacon St @ Dale St.

Part II Congested Area? ____Yes; __X__No

Part III Complex Intersection or Special Case? ____Yes; __X__No; If yes, enter location on Initial Screening Summary Sheet and proceed to next intersection; if no, proceed with Part IV.

Part IV Analyze each leg seperately on the form, below.

Leg under analysis			Cross-street data							
			Street: Bacon Leg: N				Street: Bacon Leg: S			
a Designation	b Adjusted ADT (1977-78)	c Configuration	d Adjusted ADT (1977-78)	e Configuration	f Figure/curve used	g Hot spot indicated?	h Adjusted ADT (1977-78)	i Configuration	j Figure/curve used	k Hot spot indicated?
Dale (both)	3000	2L/2W	8000	2L/2W	2-B	NO	8000	2L/2W	2-B	NO
			Street: Dale Leg: E				Street: Dale Leg: W			
Bacon (both)	8000	2L/2W	3000	2L/2W	2-B	NO	3000	2L/2W	2-B	NO

PRELIMINARY SCREENING WORK SHEET- SIGNALIZED INTERSECTIONS

page 3 of 6

City/Town: WALTHAM State: MASSACHUSETTS

Analysis By: ______ (name) ______ (title) Date: ______

Approved By: ______ (name) ______ (title) Date: ______

Part I Location: Bacon St @ School St.

Part II Congested Area? ____Yes; X No

Part III Complex Intersection or Special Case? ____Yes; X No; If yes, enter location on Initial Screening Summary Sheet and proceed to next intersection; if no, proceed with Part IV.

Part IV Analyze each leg seperately on the form, below.

Leg under analysis			Cross-street data							
			Street: Bacon Leg: N				Street: Bacon Leg: S			
a Designation	b Adjusted ADT (1977-78)	c Configuration	d Adjusted ADT (1977-78)	e Configuration	f Figure/ curve used	g Hot spot indicated?	h Adjusted ADT (1977-78)	i Configuration	j Figure/ curve used	k Hot spot indicated?
School E/leg	9000	2L/2W	8000	2L/2W	2-B	YES	8000	2L/2W	2-5	YES
School W/leg	5000	2L/2W	8000	2L/2W	2-B	NO	8000	2L/2W	2-B	NO
			Street: School Leg: E				Street: School Leg: W			
Bacon (both)	8000	2L/2W	9000	2L/2W	2-B	YES	5000	2L/2W	2-5	YES

Part I Location: Hammond St. @ Columbus St.

Part II Congested Area? ____Yes; X No

Part III Complex Intersection or Special Case? ____Yes; X No; If yes, enter location on Initial Screening Summary Sheet and proceed to next intersection; if no, proceed with Part IV.

Part IV Analyze each leg seperately on the form, below.

Leg under analysis			Cross-street data							
			Street: Hammond Leg: both				Street: ______ Leg: ______			
a Designation	b Adjusted ADT (1977-78)	c Configuration	d Adjusted ADT (1977-78)	e Configuration	f Figure/ curve used	g Hot spot indicated?	h Adjusted ADT (1977-78)	i Configuration	j Figure/ curve used	k Hot spot indicated?
Columbus (both)	5000	2L/2W	5000	2L/2W	2-B	NO				
			Street: Columbus Leg: both				Street: ______ Leg: ______			
Hammond (both)	5000	2L/2W	5000	2L/2W	2-B	NO				

PRELIMINARY SCREENING WORK SHEET- SIGNALIZED INTERSECTIONS

page 4 of 6

City/Town: WALTHAM State: MASSACHUSETTS

Analysis By: ______ (name) ______ (title) Date: ______

Approved By: ______ (name) ______ (title) Date: ______

Part I Location: High St. @ Lowell St

Part II Congested Area? ____ Yes; X No

Part III Complex Intersection or Special Case? ____ Yes; X No; If yes, enter location on Initial Screening Summary Sheet and proceed to next intersection; if no, proceed with Part IV.

Part IV Analyze each leg seperately on the form, below.

Leg under analysis			Cross-street data							
			Street: High Leg: both				Street: Leg:			
a Designation	b Adjusted ADT (1977-78)	c Configuration	d Adjusted ADT (1977-78)	e Configuration	f Figure/curve used	g Hot spot indicated?	h Adjusted ADT (1977-78)	i Configuration	j Figure/curve used	k Hot spot indicated?
Lowell (both)	2000	2L/2W	17000	2L/2W	2-8	NO				
			Street: Lowell Leg: both				Street: Leg:			
High (both)	17000	2L/2W	2000	2L/2W	2-8	YES				

Part I Location: ______

Part II Congested Area? ____ Yes; ____ No

Part III Complex Intersection or Special Case? ____ Yes; ____ No; If yes, enter location on Initial Screening Summary Sheet and proceed to next intersection; if no, proceed with Part IV.

Part IV Analyze each leg seperately on the form, below.

Leg under analysis			Cross-street data							
			Street: Leg:				Street: Leg:			
a Designation	b Adjusted ADT (1977-78)	c Configuration	d Adjusted ADT (1977-78)	e Configuration	f Figure/curve used	g Hot spot indicated?	h Adjusted ADT (1977-78)	i Configuration	j Figure/curve used	k Hot spot indicated?
			Street: Leg:				Street: Leg:			

PRELIMINARY SCREENING WORK SHEET – NONSIGNALIZED INTERSECTIONS

page 5 of 6

City/Town: WALTHAM State: MASSACHUSETTS

Analysis By: ______ (name) ______ (title) Date: ______

Approved By: ______ (name) ______ (title) Date: ______

Part I Location: Main St @ Lyman St

Part II Analyze each cross street leg on the form, below:

Through street data				Minor cross street data							
				Street: Lyman Leg ____				Street: ____ Leg ____			
a	b	c	d	e	f	g	h	i	j	k	l
Adjusted ADT (1977-78)	Configuration	Est. lane capacity	Hot Spot indicated?	Adjusted ADT (1977-78)	Configuration	Figure/curve used	Hot Spot indicated?	Adjusted ADT (1977-78)	Configuration	Figure/curve used	Hot Spot indicated?
20000	4L/2W	1700	NO	6000	2L/2W	15	NO				

Part I Location: Lexington St @ Lake St.

Part II Analyze each cross street leg on the form, below:

Through street data				Minor cross street data							
				Street: Lake Leg ____				Street: ____ Leg ____			
a	b	c	d	e	f	g	h	i	j	k	l
Adjusted ADT (1977-78)	Configuration	Est. lane capacity	Hot Spot indicated?	Adjusted ADT (1977-78)	Configuration	Figure/curve used	Hot Spot indicated?	Adjusted ADT (1977-78)	Configuration	Figure/curve used	Hot Spot indicated?
14000	4L/2W	1800	NO	7000	2L/2W	16	NO				

Part I Location: Moody St @ Crescent & Derby Sts.

Part II Analyze each cross street leg on the form, below:

Through street data				Minor cross street data							
				Street: Crescent Leg ____				Street: Derby Leg ____			
a	b	c	d	e	f	g	h	i	j	k	l
Adjusted ADT (1977-78)	Configuration	Est. lane capacity	Hot Spot indicated?	Adjusted ADT (1977-78)	Configuration	Figure/curve used	Hot Spot indicated?	Adjusted ADT (1977-78)	Configuration	Figure/curve used	Hot Spot indicated?
12000	2L/2W	1200	NO	7000	2L/2W	14	YES	4000	2L/2W	14	NO

Part I Location: Weston St. @ South St.

Part II Analyze each cross street leg on the form, below:

Through street data				Minor cross street data							
				Street: South Leg ____				Street: ____ Leg ____			
a	b	c	d	e	f	g	h	i	j	k	l
Adjusted ADT (1977-78)	Configuration	Est. lane capacity	Hot Spot indicated?	Adjusted ADT (1977-78)	Configuration	Figure/curve used	Hot Spot indicated?	Adjusted ADT (1977-78)	Configuration	Figure/curve used	Hot Spot indicated?
16000	2L/2W	1800	NO	10000	2L/2W	14	YES				

PRELIMINARY SCREENING WORK SHEET - UNINTERRUPTED FLOW

City/Town: WALTHAM State: MASS page 6 of 6

Analysis By: ____________ (name) ____________ (title) Date: ________

Approved By: ____________ (name) ____________ (title) Date: ________

a Facility	b Location	c Adjusted ADT (1977-78)	d Configuration	e Est. lane capacity	f Hot Spot Indicated?
Route 128	at Main St	99000	8L./ex.	1750	YES
Trapelo Rd	Betw. Forest & Waverly Oaks	23000	2L/A	1800	YES
Weston St	Betw. Rte 128 & Eddy St	28000	2L/A	1800	YES
South St	Betw. Brandeis Univ & Hospital	10000	2L/A	1700	NO
Beaver St.	Betw. Forest & Waverly Oaks	11000	2L/A	1800	NO

APPENDIX C

EXAMPLES OF THE HOT SPOT VERIFICATION PROCEDURE

This appendix provides examples of completed forms from a hot spot verification effort undertaken in the City of Waltham, Massachusetts. Shown in this appendix are the data sheets for the verification of the eight locations shown on the Initial Screening Summary Sheet in Appendix B, as having hot spot potential.

HOT SPOT VERIFICATION SUMMARY

City/Town: Waltham State: Mass. page 1 of 1

Analysis By: ____________ (name) ____________ (title) Date: ________

Approved By: ____________ (name) ____________ (title) Date: ________

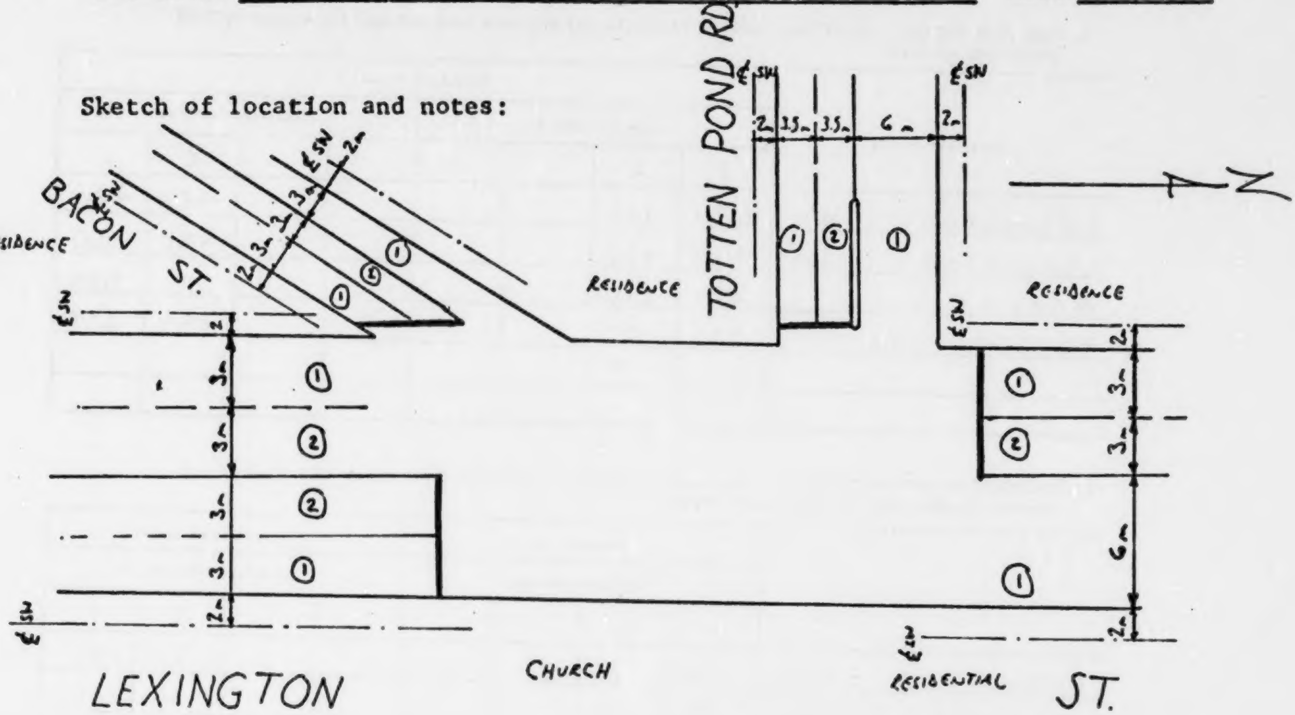
Location No.	Location	Maximum 8-hr. Ave. Concentration
15	Lexington Street at Totten Pond Road and Bacon Street	27.7 ppm
19	Bacon Street at School Street	9.6 ppm
29	High Street at Lowell Street	8.9 ppm
37	Moody Street at Crescent and Derby Streets	14.3 ppm
43	Weston Street at South Street	8.2 ppm
45	Route 128 at Main Street	17.0 ppm
46	Trapelo Road between Forest Street and Waverly Oaks Road	8.0 ppm
47	Weston Street between Route 128 and Eddy Street	9.5 ppm

HOT SPOT VERIFICATION WORK SHEET - FIELD DATA

City/Town: Waltham, Ma. By: TPM

Location: Lexington St. @ Bacon St. & Totten Pond Rd. Date: 26 Sep '75

Sketch of location and notes:


TOTTEN POND RD.
℄SW
2m
3.5m
3.5m
6m
2m
℄SW
BACON ST.
℄SW
2m
3m
2
3m
3m
2
RESIDENCE
RESIDENCE
RESIDENCE
N
℄SW
2
3m
3m
3m
3m
2m
6m
LEXINGTON ST.
CHURCH
RESIDENTIAL
①
②

Notes:

1) Parking as shown

2) Receptors at ℄ sidewalk

3) No pedestrian interference

4) Est. departure cruise speed is 30mph

5) Police directs traffic during peak hours, traffic signal off peak

HOT SPOT VERIFICATION WORK SHEET - SIGNALIZED INTERSECTION

page 1 of 3

City/Town/: WALTHAM

By: AHC

Intersection: LEXINGTON @ BACON

Date: 10/28/75

I. PEAK HOUR VOLUMES: Enter Lane Numbers (from sketch) and peak hour volumes for winter 1977-78 (from data sheets).

Intersection Leg	Peak Hour Volumes							
	Approach Lane No.				Departure Lane No.			
	1	2					2	1
LEXINGTON N/B	650	310					480	480
LEXINGTON S/B	460	460					460	460
BACON	210	210						420
TOTTON POND	530	60					295	295

II. AVERAGE G/Cy AND CRUISE SPEED: Enter average G/Cy for approach lanes (from data sheets) and average cruise speed for departure lanes.

Intersection Leg	Average G/Cy				Average Cruise Speed			
	Approach Lane No.				Departure Lane No.			
	1	2					2	1
LEXINGTON N/B	.61	.30					30	30
LEXINGTON S/B	.30	.30					30	30
BACON	.16	.16						30
TOTTON POND	.37	.06					30	30

III. RESULTING LANE CONCENTRATIONS: Enter lane concentrations for approach lanes (obtained from Figure No.), and departure lane concentrations (obtained from Figure No.).

Intersection Leg	Computed Lane Concentrations							
	Approach Lane No.				Departure Lane No.			
	1	2					2	1
LEXINGTON N/B	6.8	6.1					2.0	2.0
LEXINGTON S/B	10.4	10.4					1.9	1.9
BACON	6.8	6.8						1.7
TOTTON POND	9.6	2.4					1.1	1.1

HOT SPOT VERIFICATION WORK SHEET - SIGNALIZED INTERSECTION

page 2 of 3

Intersection: LEXINGTON @ BACON City/Town/: WALTHAM

IV-A. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factor for each lane (obtained from Figure No.) assuming receptor is on the approach side of each leg.

Intersection Leg	Distance Correction Factors							
	Approach Lane No.				Departure Lane No.			
	1	2					2	1
LEXINGTON N/B	1.32	1.18					1.08	.96
LEXINGTON S/B	1.32	1.18					1.08	.96
BACON	1.32	1.18						1.08
TOTTON POND	1.32	1.18					1.08	.96

IV-B. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factor for each lane (obtained from Figure No.) assuming receptor is on the departure side of each leg.

Intersection Leg	Distance Correction Factor							
	Approach Lane No.				Departure Lane No.			

V-A. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter the concentration from each lane corrected for lane edge to receptor distance; this is computed as the product of lane concentrations (from III, above) and the corresponding lane edge to receptor distance correction factor (from IV A, above); assuming receptor is on the approach side of each leg.

Intersection Leg	Corrected Lane Concentrations								Total
	Approach Lane No.				Departure Lane No.				
	1	2					2	1	
LEXINGTON N/B	9.0	7.2					2.2	1.9	20.3
LEXINGTON S/B	13.7	12.3					2.1	1.8	29.9
BACON	9.0	8.0						1.8	18.8
TOTTON POND	12.7	2.8					1.2	1.1	17.8

HOT SPOT VERIFICATION WORK SHEET - SIGNALIZED INTERSECTION (continued)

page 3 of 3

Intersection: LEXINGTON @ BACON City/Town/: WALTHAM

V-B. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter the concentration from each lane corrected for lane edge to receptor distance; this is computed as the product of lane concentrations (from III, above) and the corresponding lane edge to receptor distance correction factor (from IV-B, above); assuming receptor is on the departure side of each leg.

Intersection Leg	Corrected Lane Concentrations								Total
	Approach Lane No.				Departure Lane No.				

VI-A. FINAL COMPUTATIONS FOR MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following data: (1) receptor concentration (from V-A, above) in column a; (2) f_{vm} (from data sheet) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; and (4) 8-hr correlation factor (0.7 unless determined otherwise) in column f. Compute concentrations as shown in columns c, e, and g. Assume receptor is on the approach side of each leg.

Intersection Leg	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
LEXINGTON N/B	20.3	1.16	23.5	5.0	28.5	.7	20.0
LEXINGTON S/B	29.9	1.16	34.7	5.0	39.7	.7	27.7
BACON	18.8	1.04	19.2	5.0	24.2	.7	16.9
TOTTON POND	17.8	1.04	18.2	5.0	23.2	.7	16.2

VI-B. FINAL COMPUTATIONS FOR MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following data; (1) receptor concentration (from V-B, above) in column a; (2) f_{vm} (from data sheet) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; and (4) 8-hr correlation factor (0.7 unless determined otherwise) in column f. Compute concentrations as shown in columns c, e, and g. Assume receptor is on the departure side of each leg.

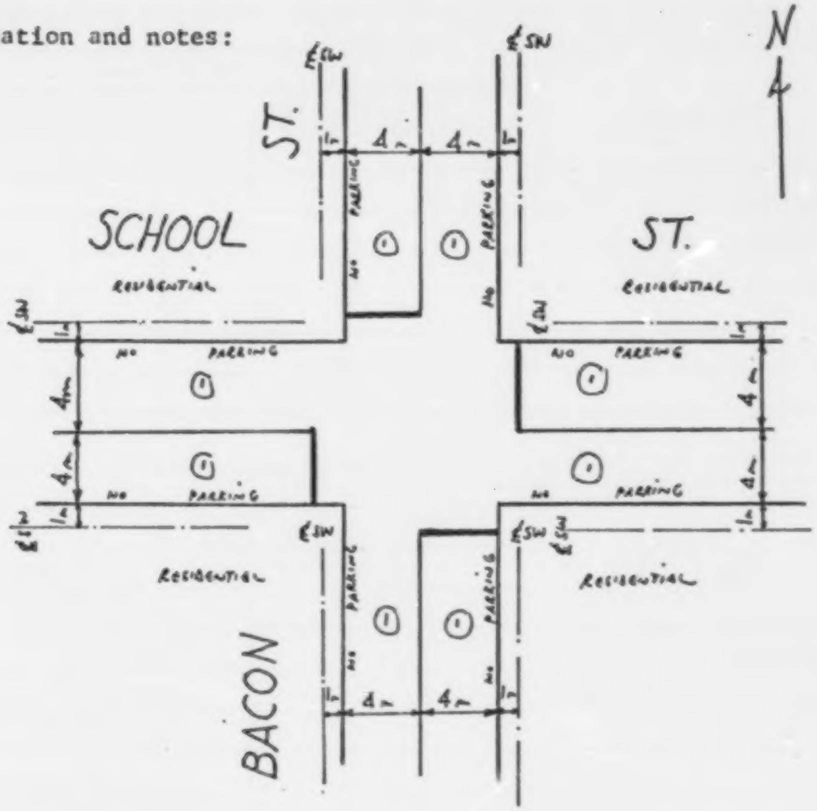
Intersection Leg	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)

HOT SPOT VERIFICATION WORK SHEET - FIELD DATA

City/Town: Waltham. Ma. By: TPM

Location: Bacon St. @ School St Date: 26 Sep '75

Sketch of location and notes:


N
SCHOOL ST.
BACON ST.
℄ SW
1m
4m
NO PARKING
RESIDENTIAL
①

Notes:

1) Parking as shown

2) Receptors at ℄ sidewalk

3) No pedestrian interference

4) Assume departure cruise speed is 30 mph

5) Traffic signal controls

HOT SPOT VERIFICATION WORK SHEET - SIGNALIZED INTERSECTION

page 1 of 3

City/Town/: WALTHAM By: AHC

Intersection: BACON @ SCHOOL Date: 10/26/75

I. PEAK HOUR VOLUMES: Enter Lane Numbers (from sketch) and peak hour volumes for winter 1977-78 (from data sheets).

Intersection Leg	Peak Hour Volumes							
	Approach Lane No.				Departure Lane No.			
	1							1
BACON S/B	270							270
BACON N/B	240							240
SCHOOL (E/B = W/B)	270							270

II. AVERAGE G/Cy AND CRUISE SPEED: Enter average G/Cy for approach lanes (from data sheets) and average cruise speed for departure lanes.

Intersection Leg	Average G/C_y				Average Cruise Speed			
	Approach Lane No.				Departure Lane No.			
	1							1
BACON S/B	.45							30
BACON N/B	.45							30
SCHOOL	.35							30

III. RESULTING LANE CONCENTRATIONS: Enter lane concentrations for approach lanes (obtained from Figure No.), and departure lane concentrations (obtained from Figure No.).

Intersection Leg	Computed Lane Concentrations							
	Approach Lane No.				Departure Lane No.			
	1							1
BACON S/B	5.2							1.0
BACON N/B	4.4							.9
SCHOOL	6.1							1.0

HOT SPOT VERIFICATION WORK SHEET - SIGNALIZED INTERSECTION (continued)

page 2 of 3

Intersection: BACON @ SCHOOL **City/Town/:** WALTHAM

IV-A. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factor for each lane (obtained from Figure No.) assuming receptor is on the approach side of each leg.

Intersection Leg	Distance Correction Factors							
	Approach Lane No.				Departure Lane No.			
	1							1
BACON S/B	1.32							1.18
BACON N/B	1.32							1.18
SCHOOL	1.32							1.18

IV-B. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factor for each lane (obtained from Figure No.) assuming receptor is on the departure side of each leg.

Intersection Leg	Distance Correction Factor							
	Approach Lane No.				Departure Lane No.			

V-A. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter the concentration from each lane corrected for lane edge to receptor distance; this is computed as the product of lane concentrations (from III, above) and the corresponding lane edge to receptor distance correction factor (from IV A, above); assuming receptor is on the approach side of each leg.

Intersection Leg	Corrected Lane Concentrations								Total
	Approach Lane No.				Departure Lane No.				
	1							1	
BACON S/B	6.7							1.2	7.9
BACON N/B	5.8							1.0	6.8
SCHOOL	3.0							1.2	9.2

HOT SPOT VERIFICATION WORK SHEET - SIGNALIZED INTERSECTION (continued)

page 3 of 3

Intersection: BACON @ SCHOOL City/Town/: WALTHAM

V-B. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter the concentration from each lane corrected for lane edge to receptor distance; this is computed as the product of lane concentrations (from III, above) and the corresponding lane edge to receptor distance correction factor (from IV-B, above); assuming receptor is on the departure side of each leg.

Intersection Leg	Corrected Lane Concentrations								Total
	Approach Lane No.				Departure Lane No.				

VI-A. FINAL COMPUTATIONS FOR MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following data: (1) receptor concentration (from V-A, above) in column a; (2) f_{vm} (from data sheet) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; and (4) 8-hr correlation factor (0.7 unless determined otherwise) in column f. Compute concentrations as shown in columns c, e, and g. Assume receptor is on the approach side of each leg.

Intersection Leg	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
BACON S/B	7.9	1.04	8.2	5.0	13.2	.7	9.2
BACON N/B	6.8	1.04	7.1	5.0	12.1	.7	8.5
SCHOOL (E/B = W/B)	9.2	.95	8.7	5.0	13.7	.7	9.6

VI-B. FINAL COMPUTATIONS FOR MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following data; (1) receptor concentration (from V-B, above) in column a; (2) f_{vm} (from data sheet) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; and (4) 8-hr correlation factor (0.7 unless determined otherwise) in column f. Compute concentrations as shown in columns c, e, and g. Assume receptor is on the departure side of each leg.

Intersection Leg	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)

HOT SPOT VERIFICATION WORK SHEET - FIELD DATA

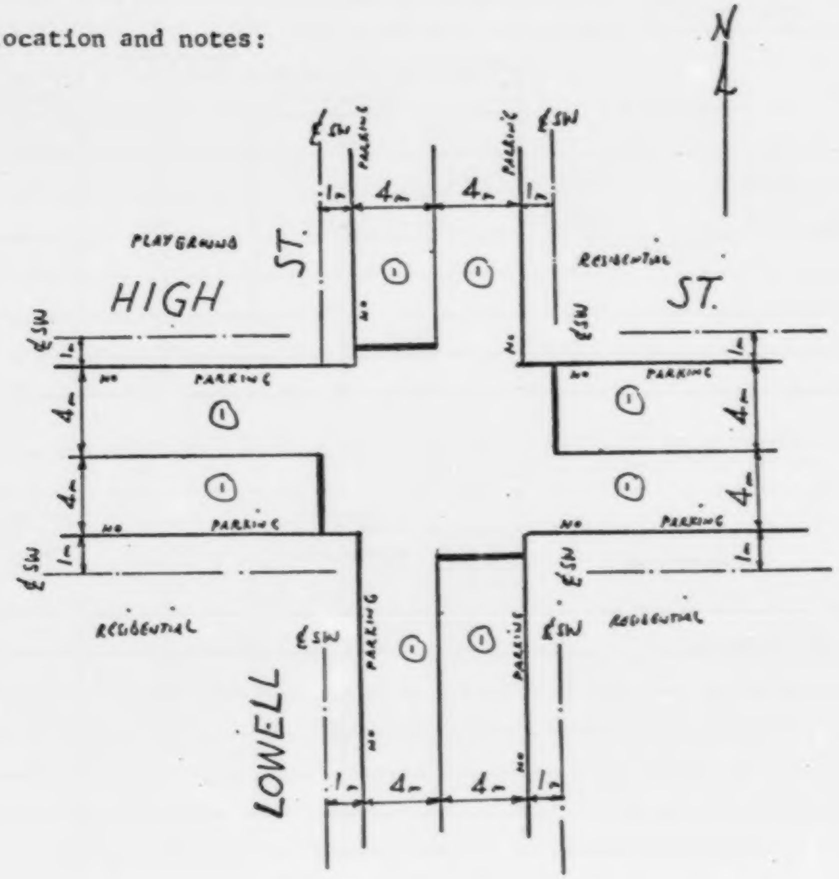
City/Town: Waltham, Ma.

By: TPM

Location: Lowell St. @ High St.

Date: 26 Sep '75

Sketch of location and notes:


N
℄ SW
PARKING
1m
4m
PLAYGROUND
HIGH ST.
RESIDENTIAL
NO PARKING
①
LOWELL ST.

Notes:

1) Parking as shown

2) Receptors at ℄ sidewalk

3) No pedestrian interference

4) Est. departure cruise speed is 30mph

5) Traffic signal controls

HOT SPOT VERIFICATION WORK SHEET - SIGNALIZED INTERSECTION

page 1 of 3

City/Town/: WALTHAM

By: AHC

Intersection: HIGH @ LOWELL

Date: 10/28/75

I. PEAK HOUR VOLUMES: Enter Lane Numbers (from sketch) and peak hour volumes for winter 1977-78 (from data sheets).

Intersection Leg	Peak Hour Volumes							
	Approach Lane No.				Departure Lane No.			
	1							1
HIGH W/B	375							375
HIGH E/B								
(IDENTICAL)								

II. AVERAGE G/Cy AND CRUISE SPEED: Enter average G/Cy for approach lanes (from data sheets) and average cruise speed for departure lanes.

Intersection Leg	Average G/C_y				Average Cruise Speed			
	Approach Lane No.				Departure Lane No.			
	1							1
HIGH	.62							30

III. RESULTING LANE CONCENTRATIONS: Enter lane concentrations for approach lanes (obtained from Figure No.), and departure lane concentrations (obtained from Figure No.).

Intersection Leg	Computed Lane Concentrations							
	Approach Lane No.				Departure Lane No.			
	1							1
HIGH	4.6							1.4

HOT SPOT VERIFICATION WORK SHEET - SIGNALIZED INTERSECTION (continued)

page 2 of 3

Intersection: HIGH @ LOWELL City/Town/: WALTHAM

IV-A. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factor for each lane (obtained from Figure No.) assuming receptor is on the approach side of each leg.

Intersection Leg	Distance Correction Factors							
	Approach Lane No.				Departure Lane No.			
	1							1
HIGH	1.30							1.13

IV-B. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factor for each lane (obtained from Figure No.) assuming receptor is on the departure side of each leg.

Intersection Leg	Distance Correction Factor							
	Approach Lane No.				Departure Lane No.			

V-A. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter the concentration from each lane corrected for lane edge to receptor distance; this is computed as the product of lane concentrations (from III, above) and the corresponding lane edge to receptor distance correction factor (from IV A, above); assuming receptor is on the approach side of each leg.

Intersection Leg	Corrected Lane Concentrations								Total
	Approach Lane No.				Departure Lane No.				
	1							1	
HIGH ST.	5.9							1.7	7.6

HOT SPOT VERIFICATION WORK SHEET - SIGNALIZED INTERSECTION (continued)

page 3 of 3

Intersection: HIGH @ LOWELL City/Town/: WALTHAM

V-B. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter the concentration from each lane corrected for lane edge to receptor distance; this is computed as the product of lane concentrations (from III, above) and the corresponding lane edge to receptor distance correction factor (from IV-B, above); assuming receptor is on the departure side of each leg.

Intersection Leg	Corrected Lane Concentrations								Total
	Approach Lane No.				Departure Lane No.				

VI-A. FINAL COMPUTATIONS FOR MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following data: (1) receptor concentration (from V-A, above) in column a; (2) f_{vm} (from data sheet) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; and (4) 8-hr correlation factor (0.7 unless determined otherwise) in column f. Compute concentrations as shown in columns c, e, and g. Assume receptor is on the approach side of each leg.

Intersection Leg	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
HIGH	7.6	1.02	7.8	5.0	12.8	.7	8.9

VI-B. FINAL COMPUTATIONS FOR MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following data; (1) receptor concentration (from V-B, above) in column a; (2) f_{vm} (from data sheet) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; and (4) 8-hr correlation factor (0.7 unless determined otherwise) in column f. Compute concentrations as shown in columns c, e, and g. Assume receptor is on the departure side of each leg.

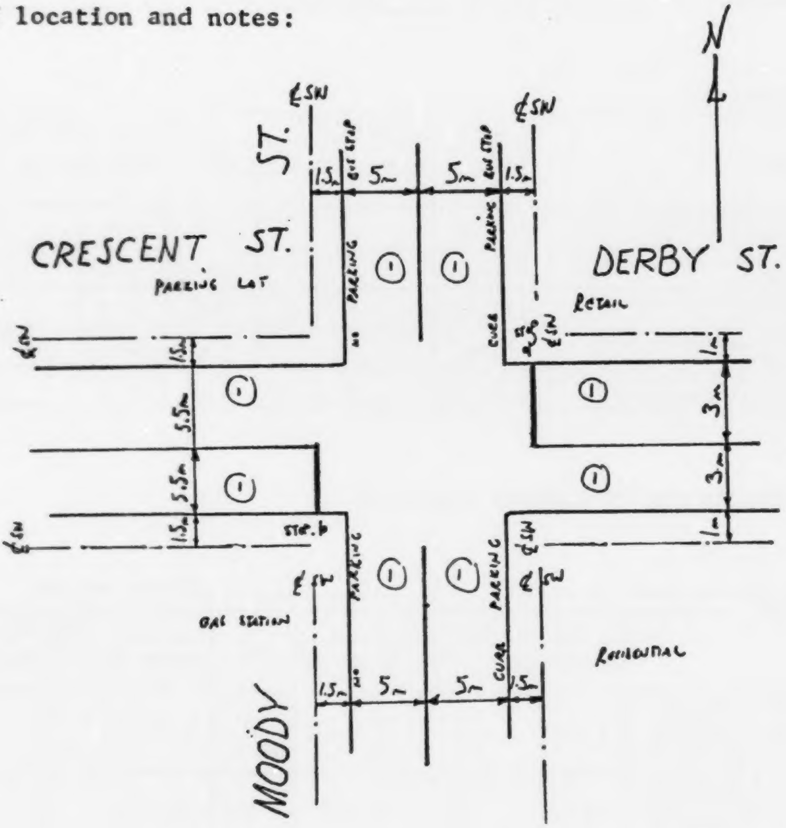
Intersection Leg	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)

HOT SPOT VERIFICATION WORK SHEET - FIELD DATA

City/Town: Waltham, Ma. By: TPM

Location: Moody St. @ Crescent & Derby Sts. Date: 26 Sep '75

Sketch of location and notes:


N
℄SW
℄SW
ST.
BUS STOP
BUS STOP
1.5m
5m
5m
1.5m
CRESCENT ST.
PARKING LOT
PARKING
PARKING
①
①
DERBY ST.
RETAIL
CURB
STOP
℄SW
℄SW
1.5m
5.5m
5.5m
1.5m
1m
3m
3m
1m
STOP
℄SW
℄SW
℄SW
℄SW
GAS STATION
RESIDENTIAL
CURB
MOODY
1.5m
5m
5m
1.5m

Notes:

1) Parking as shown
2) Receptors at ℄ sidewalk
3) Est. departure cruise speed is 25 mph
4) Stop sign controls Crescent & Derby Sts.

HOT SPOT VERIFICATION WORK SHEET - NONSIGNALIZED INTERSECTION

page 1 of 2

City/Town: WALTHAM

By: AHC

Intersection: MOODY ST. @ CRESCENT & DERBY STS.

Date: 10/28/75

Type of Control: ___all-way STOP; X 1 or 2-way STOP; ___YIELD; ___None;

Street Controlled: CRESCENT & DERBY STS

I. BASIC COMPUTATIONS:

Item	Leg: CRESCENT				Leg: DERBY			
	Approach Lane No.		Departure Lane No.		Approach Lane No.		Departure Lane No.	
	1			1	1			1
A. VOLUMES: Enter peak hour volumes for winter 1977-78 (from data sheets)	330			330	150			150
B. LANE CAPACITY: Enter lane capacity of approach lanes (from data sheets)	410		X	X	410		X	X
C. V/C: Enter V/C for approach lanes (computed as as A ÷ B, above)	.80		X	X	.37		X	X
D. CRUISE SPEED: Enter departure lane cruise speed (from data sheets)	X	X		25	X	X		25
E. LANE CONCENTRATIONS: Enter lane concentrations computed from A, C, and D, above, and Fig.	10.4			1.7	1.3			.8

II. CORRECT FOR LANE EDGE TO RECEPTOR DISTANCES:

Assume receptor is on APPROACH side of street

Item	Leg: CRESCENT				TOTAL	Leg: DERBY				TOTAL
	Approach Lane No.		Departure Lane No.			Approach Lane No.		Departure Lane No.		
	1			1		1			1	
A. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig.)	1.24			1.11	X	1.30			1.24	X
B. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-E and II-A, above	12.9			1.9	14.8	1.7			1.0	2.7

Assume receptor is on ____________ side of street

Item	Leg: ______				TOTAL	Leg: ______				TOTAL
	Approach Lane No.		Departure Lane No.			Approach Lane No.		Departure Lane No.		
C. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig.)					X					X
D. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-E and II-C, above										

HOT SPOT VERIFICATION WORK SHEET - NONSIGNALIZED INTERSECTION (continued)

page 2 of 2

City/Town: WALTHAM

Intersection: MOODY ST @ CRESCENT & DERBY STS

Street Controlled: CRESCENT & DERBY STS.

III. FINAL COMPUTATIONS OF MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATION

Intersection Leg: CRESCENT

Item	Receptor Location (street-side)	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
A. FINAL COMPUTATIONS OF 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following; (1) total receptor concentrations (from II-B and II-D, above) in column a; (2) f_{vm} (from data sheets) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; (4) 8-hr correlation factor (0.7 unless otherwise determined) in column f, Compute final concentrations as shown in columns c, e, and g, for receptors on both sides of street	Appro.	14.8	1.04	15.4	5.0	20.4	0.7	14.3

Intersection Leg: DERBY

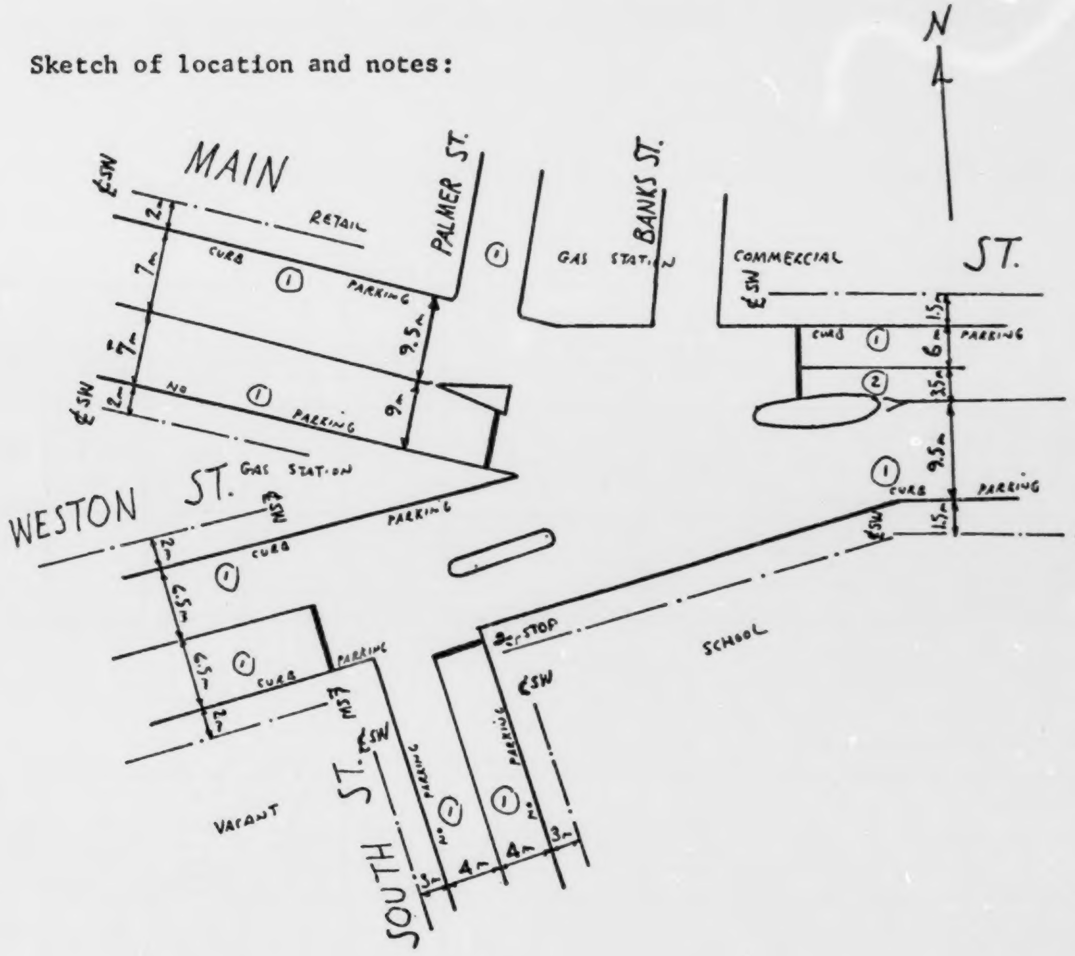
Item	Receptor Location (street-side)	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
A. FINAL COMPUTATIONS OF 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following; (1) total receptor concentrations (from II-B and II-D, above) in column a; (2) f_{vm} (from data sheets) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; (4) 8-hr correlation factor (0.7 unless otherwise determined) in column f, Compute final concentrations as shown in columns c, e, and g, for receptors on both sides of street	Appro.	2.7	.95	2.6	5.0	7.6	0.7	5.3

HOT SPOT VERIFICATION WORK SHEET - FIELD DATA

City/Town: Waltham, Ma By: TPM

Location: Main St. @ Weston St. & South St. Date: 22 Sep '75

Sketch of location and notes:


N
MAIN
ST.
PALMER ST.
BANKS ST.
RETAIL
GAS STATION
COMMERCIAL
CURB
PARKING
NO PARKING
① ②
2m 7m 7m 2m 9.5m 9m
1.5m 6m 3.5m 9.5m 1.5m
℄ SW
WESTON ST.
GAS STATION
2m 6.5m 6.5m 2m
St. STOP
SCHOOL
VACANT
SOUTH ST.
3m 4m 4m 3m

Notes:

1) Parking as shown
2) Receptors at ℄ sidewalk
3) Insignificant pedestrian interference during peak hours
4) South Street controlled by flashing red
5) Mixed commercial/residential; Est. departure speeds - 25 mph on South St; 30 mph on Main and Weston Sts.
6) Traffic signals control all except South St.

HOT SPOT VERIFICATION WORK SHEET - NONSIGNALIZED INTERSECTION

page 1 of 2

City/Town: WALTHAM By: AHC

Intersection: WESTON ST @ SOUTH ST Date: 10/22/75

Type of Control: __all-way STOP; X 1 ~~or 2~~-way STOP; __YIELD; __None;

Street Controlled: SOUTH ST

I. BASIC COMPUTATIONS:

Item	Leg: SCUTH ST				Leg:			
	Approach Lane No.		Departure Lane No.		Approach Lane No.		Departure Lane No.	
	1			1				
A. VOLUMES: Enter peak hour volumes for winter 1977-78 (from data sheets)	480			240				
B. LANE CAPACITY: Enter lane capacity of approach lanes (from data sheets)	930		☒	☒			☒	☒
C. V/C: Enter V/C for approach lanes (computed as as A ÷ B, above)	.52		☒	☒			☒	☒
D. CRUISE SPEED: Enter departure lane cruise speed (from data sheets)	☒	☒		25	☒	☒		
E. LANE CONCENTRATIONS: Enter lane concentrations computed from A, C, and D, above, and Fig.	4.3			1.1				

II. CORRECT FOR LANE EDGE TO RECEPTOR DISTANCES:

Assume receptor is on APPROACH side of street

Item	Leg: SOUTH ST				TOTAL	Leg:				TOTAL
	Approach Lane No.		Departure Lane No.			Approach Lane No.		Departure Lane No.		
	1			1						
A. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig.)	1.32			1.20	☒					☒
B. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-E and II-A, above	5.7			1.3	7.0					

Assume receptor is on __________ side of street

Item	Leg:				TOTAL	Leg:				TOTAL
	Approach Lane No.		Departure Lane No.			Approach Lane No.		Departure Lane No.		
C. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig.)					☒					☒
D. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-E and II-C, above										

HOT SPOT VERIFICATION WORK SHEET - NONSIGNALIZED INTERSECTION (continued)

page 2 of 2

City/Town: WALTHAM

Intersection: WESTON ST @ SOUTH ST.

Street Controlled: SOUTH ST.

III. FINAL COMPUTATIONS OF MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATION

Intersection Leg: SOUTH ST

Item	Receptor Location (street-side)	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
A. FINAL COMPUTATIONS OF 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following: (1) total receptor concentrations (from II-B and II-D, above) in column a; (2) f_{vm} (from data sheets) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; (4) 8-hr correlation factor (0.7 unless otherwise determined) in column f. Compute final concentrations as shown in columns c, e, and g, for receptors on both sides of street	App..	7.0	.95	6.7	5.0	11.7	0.7	8.2

Intersection Leg: ____________

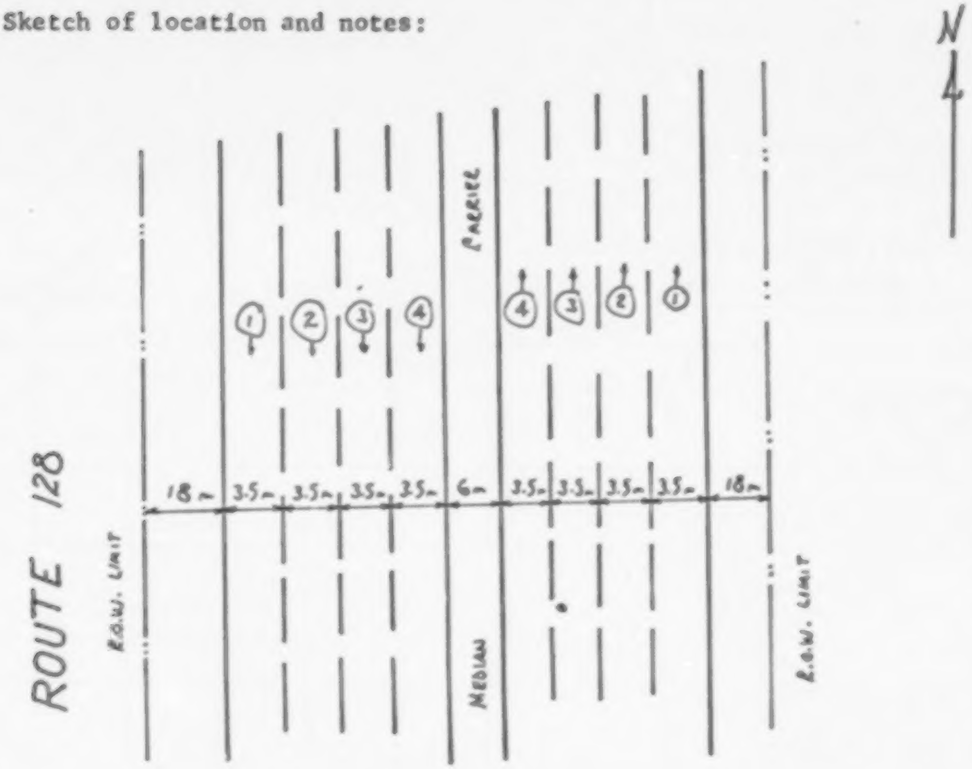
Item	Receptor Location (street-side)	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
A. FINAL COMPUTATIONS OF 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following: (1) total receptor concentrations (from II-B and II-D, above) in column a; (2) f_{vm} (from data sheets) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; (4) 8-hr correlation factor (0.7 unless otherwise determined) in column f. Compute final concentrations as shown in columns c, e, and g, for receptors on both sides of street								

HOT SPOT VERIFICATION WORK SHEET - FIELD DATA

City/Town: Waltham, Ma. By: TPM

Location: Route 128 Between Main & Weston Sts. Date: 26 Sep '75

Sketch of location and notes:


N
ROUTE 128
R.O.W. LIMIT
BARRIER
MEDIAN
R.O.W. LIMIT
18m
3.5m
3.5m
3.5m
3.5m
6m
3.5m
3.5m
3.5m
3.5m
18m
①
②
③
④
④
③
②
①

Notes:

1) Level terrain

2) Receptor at R.O.W. limit

HOT SPOT VERIFICATION WORK SHEET - UNINTERRUPTED FLOW

page 1 of 1

City/Town: WALTHAM

By: AHC

Street/Highway Section: U.S. ROUTE 128 (@ MAIN ST)

Date: 10/28/75

I. BASIC COMPUTATIONS:

Item	SOUTH bound Lane No.				NORTH bound Lane No.			
	1	2	3	4	4	3	2	1
A. VOLUMES: Enter peak hour volumes for winter 1977-78 (from data sheets)	1080	1480	1600	1540	1400	1460	1350	990
B. LANE CAPACITY: Enter lane capacity (from data sheets)	1770	1770	1770	1770	1770	1770	1770	1770
C. V/C: Enter V/C for each lane (A ÷ B, above)	.61	.84	.90	.87	.79	.82	.76	.56
D. LANE CONCENTRATIONS: Enter lane concentrations computed from A and C, above, and Figure	2.7	4.5	5.1	4.8	4.2	4.7	3.8	2.5

II. CORRECT FOR LANE EDGE TO RECEPTOR DISTANCES:

Assume receptor is on WEST side of street

Item	SOUTH bound Lane No.				NORTH bound Lane No.				TOTAL
	1	2	3	4	4	3	2	1	
A. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig.)	.71	.65	.60	.56	.50	.47	.43	.40	☒
B. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-D and II-A, above	1.9	2.8	3.1	2.7	2.1	2.2	1.6	1.0	17.4

Assume receptor is on ______ side of street

Item	______ bound Lane No.				______ bound Lane No.				TOTAL
C. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig.)									☒
D. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-D and II-C, above									

III. FINAL COMPUTATIONS OF MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS

Item	Receptor Location (street-side)	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
A. FINAL COMPUTATIONS OF 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following: (1) total receptor concentrations (from II-B and II-D, above) in column a; (2) f_{vm} (from data sheets) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; (4) 8-hr correlation factor (0.7 unless otherwise determined) in column f. Compute final concentrations as shown in columns c, e, and g, for receptors on both sides of street	WEST	17.4	1.11	19.3	5.0	24.3	0.7	17.0

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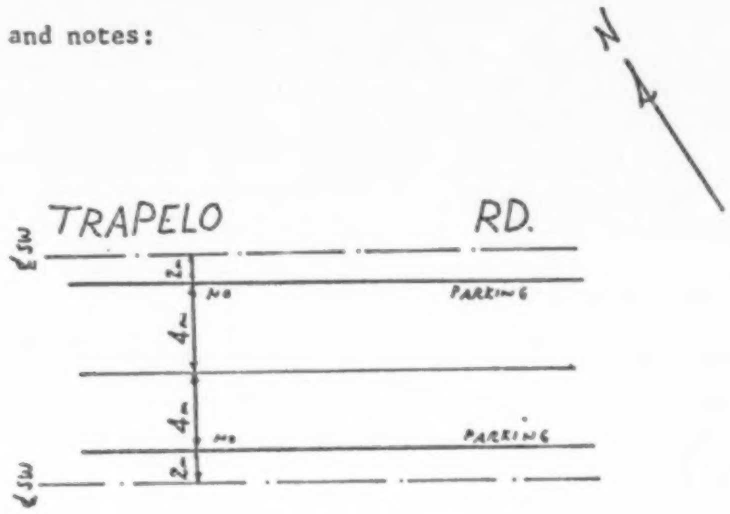
HOT SPOT VERIFICATION WORK SHEET - FIELD DATA

City/Town: Waltham, Ma. By: TPM

Location: Trapelo Rd. btwn Forest St. & Waverly Oaks Rd. Date: 26 Sep '75

Sketch of location and notes:


N
TRAPELO RD.
℄ SW
2m
NO PARKING
4m
4m
NO PARKING
2m
℄ SW

Notes:

1) Parking as noted

2) Receptor at ℄ sidewalk

HOT SPOT VERIFICATION WORK SHEET - UNINTERRUPTED FLOW

page 1 of 1

City/Town: WALTHAM

By: AHC

Street/Highway Section: TRAPELO RD

Date: 10/22/75

I. BASIC COMPUTATIONS:

Item	EAST bound Lane No.				WEST bound Lane No.			
	1							1
A. VOLUMES: Enter peak hour volumes for winter 1977-75 (from data sheets)	660							660
B. LANE CAPACITY: Enter lane capacity (from data sheets)	1300							1300
C. V/C: Enter V/C for each lane (A ÷ B, above)	.37							.37
D. LANE CONCENTRATIONS: Enter lane concentrations computed from A and C, above, and Figure	2.6							2.6

II. CORRECT FOR LANE EDGE TO RECEPTOR DISTANCES:

Assume receptor is on NORTH side of street

Item	EAST bound Lane No.				WEST bound Lane No.				TOTAL
	1							1	
A. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig.)	1.32							1.14	☒
B. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-D and II-A, above	3.4							2.9	6.3

Assume receptor is on ________ side of street

Item	____ bound Lane No.				____ bound Lane No.				TOTAL
C. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig.)									☒
D. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-E and II-C, above									

III. FINAL COMPUTATIONS OF MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS

Item	Receptor Location (street-side)	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
A. FINAL COMPUTATIONS OF 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following: (1) total receptor concentrations (from II-B and II-D, above) in column a; (2) f_{vm} (from data sheets) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; (4) 8-hr correlation factor (0.7 unless otherwise determined) in column f. Compute final concentrations as shown in columns c, e, and g, for receptors on both sides of street	Both	6.3	1.02	6.4	5.0	11.4	0.7	8.0

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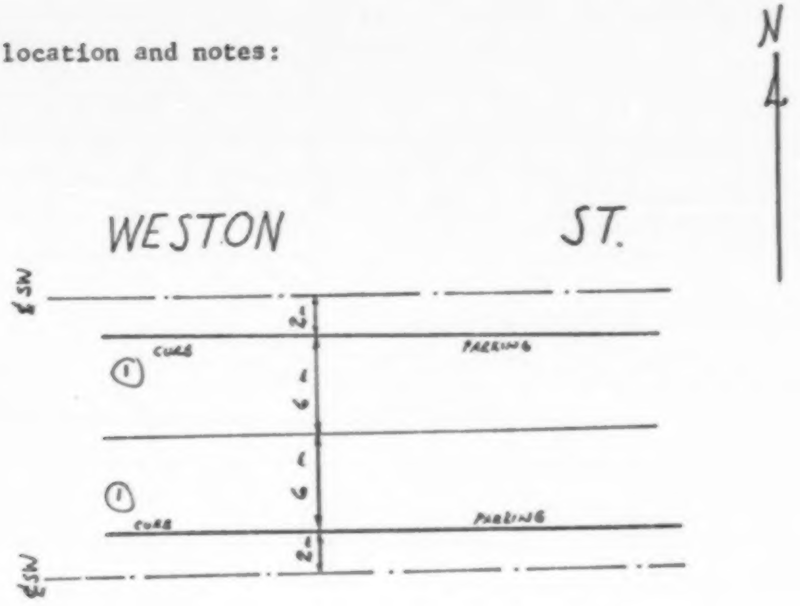
HOT SPOT VERIFICATION WORK SHEET - FIELD DATA

City/Town: WALTHAM, MA. By: TPM

Location: WESTON ST. BTWN RT. 128 & EDDY ST. Date: 26 Sep 75

Sketch of location and notes:


N
WESTON ST.
℄ SW
2'
CURB
PARKING
①
16'
16'
①
CURB
PARKING
2'
℄ SW

NOTES:

1) PARKING AS SHOWN

2) RECEPTOR AT ℄ SIDEWALK

HOT SPOT VERIFICATION WORK SHEET - UNINTERRUPTED FLOW

page 1 of 1

City/Town: WALTHAM

By: AHC

Street/Highway Section: WESTON ST

Date: 10/28/75

I. BASIC COMPUTATIONS:

Item	WEST bound Lane No.				EAST bound Lane No.			
	1							1
A. VOLUMES: Enter peak hour volumes for winter 1977-78 (from data sheets)	770							770
B. LANE CAPACITY: Enter lane capacity (from data sheets)	1800							1800
C. V/C: Enter V/C for each lane (A ÷ B, above)	.43							.43
D. LANE CONCENTRATIONS: Enter lane concentrations computed from A and C, above, and Figure	3.1							3.1

II. CORRECT FOR LANE EDGE TO RECEPTOR DISTANCES:

Assume receptor is on NORTH side of street

Item	WEST bound Lane No.				EAST bound Lane No.				TOTAL
	1							1	
A. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig.)	1.27							1.05	☒
B. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-D and II-A, above	4.0							3.3	7.3

Assume receptor is on ______ side of street

Item	____ bound Lane No.				____ bound Lane No.				TOTAL
C. LANE EDGE TO RECEPTOR DISTANCE CORRECTION FACTORS: Enter lane edge to receptor distance correction factors for each lane (obtained from Fig.)									☒
D. RECEPTOR CONCENTRATIONS ATTRIBUTABLE TO EACH LANE: Enter corrected concentrations, computed as the product of I-E and II-C, above									

III. FINAL COMPUTATIONS OF MAXIMUM 1-HR AND 8-HR AVERAGE CONCENTRATIONS

Item	Receptor Location (street-side)	a Computed Receptor Conc.	b f_{vm}	c Corrected Conc. (a x b)	d Back-ground Conc.	e Total 1-hr ave. Conc. (c + d)	f 8-hr. Correlat. Factor	g Est. 8-hr Ave. Conc. (e x f)
A. FINAL COMPUTATIONS OF 1-HR AND 8-HR AVERAGE CONCENTRATIONS: Enter the following: (1) total receptor concentrations (from II-B and II-D, above) in column a; (2) f_{vm} (from data sheets) in column b; (3) background concentration (5ppm unless determined otherwise) in column d; (4) 8-hr correlation factor (0.7 unless otherwise determined) in column f. Compute final concentrations as shown in columns c, e, and g, for receptors on both sides of street	NORTH	7.3	1.16	8.5	5.0	13.5	0.7	9.5

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